

**STORMWATER MANAGEMENT  
DESIGN NARRATIVE**

**FOR THE**

**GREENSBORO TRANSFER STATION  
GUILFORD COUNTY, NORTH CAROLINA**

*Prepared for:*

**City of Greensboro, North Carolina**



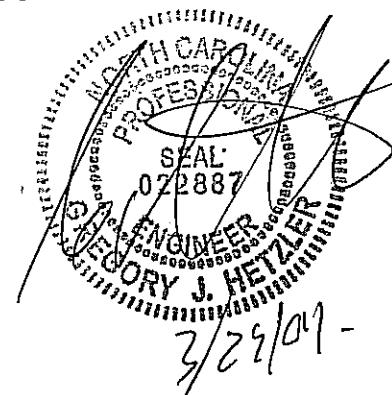
*Prepared by:*

**HDR Engineering, Inc. of the Carolinas  
128 S. Tryon Street, Suite 1400  
Charlotte, NC 28202-5004**

**HDR**

HDR Project No. 06770-02707-018

**March 2004**



## TABLE OF CONTENTS

<u>SECTION</u>		<u>PAGE</u>
	TABLE OF CONTENTS .....	i
1.0	INTRODUCTION .....	1
2.0	EXISTING SITE CHARACTERISTICS .....	1
3.0	PROPOSED SITE IMPROVEMENTS .....	2
4.0	BASIS OF DESIGN .....	2
5.0	HYDROLOGIC ANALYSES .....	3
5.1	Stormwater Runoff Determination Procedure.....	3
5.1.1	Storm Precipitation .....	3
5.1.2	Drainage Basin Delineation .....	4
5.1.3	Soil Characteristics .....	4
5.1.4	Time of Concentration .....	4
5.1.5	Runoff Conveyance .....	4
5.2	Control of Stormwater Runoff .....	4
5.3	Stormwater Quality Treatment Volume – Wet Pond BMP.....	6

## FIGURES

- 1 Site Location Map
- 2 Topography Plan
- 3 SCS Soils Map
- 4 Existing Drainage Areas
- 5 Proposed Drainage Areas

## CALCULATIONS

- 6 Land Use Coverage
- 7 Predevelopment Drainage Areas
- 8 Predevelopment Flow Lengths
- 9 Post-development Drainage Areas
- 10 Post-development Flow Lengths
- 11 Wet Pond WQ (Water Quality TSS Removal) and Pond Sediment Storage
- 12 Summary of Stormwater Peak Runoff Quantities
- 13 Multi-Hydrograph Plot, Pre- vs. Post-Development for 1-, 2-, 10-, 25-, and 100-Year Events
- 14 Hydraflow Hydrographs Model Report
  - a. Model Schematic
  - b. Table of Contents – 10-Year Reports
  - c. Hydrograph Return Period Recap 1-, 2-, 10-, 25-, and 100-Year Events
  - d. 10-Year Summary Report
  - e. 10-Year Hydrograph Reports
  - f. Water Quality Pond (Routing) 1-, 2-, 10-, 25-, and 100-Year Events
  - g. Pond Report
- 15 Stormdrain Collection System Design – Hydraflow Storm Sewers 2000, by Intelisolve

## **1.0 INTRODUCTION**

The City of Greensboro, North Carolina (the City), retained HDR Engineering, Inc. of the Carolinas (HDR) to assist with the siting and permitting of the proposed Residential Municipal Solid Waste (MSW) Transfer Station Facility (Facility). The Facility is located at the corner of Burnt Poplar and Chimney Rock Roads (see Figure 1, located in Appendices). The Facility will accept MSW from commercial haulers and local citizens within the disposal area. This Stormwater Management Design Narrative (Report) summarizes design characteristics of proposed stormwater runoff. The stormwater design generally conforms to the regulations of the North Carolina Department of Environment and Natural Resources (NCDENR), South Carolina Solid Waste Management Regulations, and the City of Greensboro Stormwater Management Manual.

Criteria incorporated with this design include analysis of stormwater runoff quantities, collection and attenuation of peak runoff flows, and maintenance stormwater treatment.

## **2.0 EXISTING SITE CHARACTERISTICS**

The site is located within the area depicted on the Guilford Quadrangle, North Carolina, United States Geological Survey (USGS) 7.5-Minute Series Topographic Quadrangle Map. The overall site consists of 9.4 acres of vacant land. The land is characterized with Scrub/Shrub vegetation (see Figure 2 located in the Appendices).

The site is bounded by vacant wooded property on the west, Chimney Rock Road on the East, Burnt Poplar Road to the south, and a petroleum tank storage facility to the north (see Figure 1).

The existing natural ground surface elevations on site vary from 897 to 928 feet mean sea level (MSL) generally sloping northeast to west. Two existing ditches drain to one outfall located on the west boundary, 400 feet north of Burnt Poplar Road. This ditch outfall is at elevation 897 ft. MSL. Runoff drains across the adjacent property to Burnt Poplar Road where a culvert crossing is located, greater than 300 feet west of the project.

Two major soil series, Enon (En) and Mecklenburg (Mh), dominate the Site [United States Department of Agriculture (USDA, 1977)]. The En series consists of very deep, well-drained, slowly permeable soils on ridge tops and side slopes. Within the Site, En fine sandy loam is present on slopes ranging from 2 to 10 percent. In addition, the Enon-Urban land complex is present. The Mh series consists of very deep, well-drained, slowly permeable soils that formed in residuum weathered from intermediate and mafic crystalline rocks of the Piedmont uplands. The Mh soils found within the Site include sandy clay loam with eroded slopes ranging from 2 to 6 percent and the Mh-Urban land complex (USDA, 1977). The soil groups are listed as being Hydrologic Soil Group D (see Figure 3 located in the Appendices).

The Federal Emergency Management Agency (FEMA) National Flood Insurance Program Flood Insurance Rate Maps (FIRMs) were obtained to determine the location of flood hazard areas in proximity to the Study Area. The FIRM for the site (Community Panel Number 375351 0011C) was checked to verify floodplain locations. The site is located in Zone X, areas determined to be outside of the 500-year floodplain.

Stream and wetland delineations were investigated and do not present any potential impacts to the site or Facility.

Stormwater modeling of the existing development conditions accounted for division of flows into defined drainage areas. The overall drainage area extending from just downgradient of the outfall was measured to be 10.1 acres in size. The subbasins included a major area of the site, 8.1 acres; 1.1 acre area along Chimney Rock Road; a 0.6 acre area along Burnt Poplar Road; and a small 0.25 acre area along the northern boundary, along the drainage berm adjacent the petroleum storage property (see Calculations 4 and 5).

These drainage areas collect at a nondescript point just downstream of the site outfall. The subbasins are accounted for and are included in portions of the affected site development that flow to the area of the outfall. This outfall receives flows from two main ditches. One ditch drains from the north and east side of the property. The second ditch drains from the southeast side of the property.

Some roadside drainage flows onto the site from Chimney Rock Road, as the swale has poor definition, resulting in flows from larger events crossing onto the site drainage areas.

### **3.0 PROPOSED SITE IMPROVEMENTS**

Facility improvements that are planned include two entry drives, truck scale house, transfer station building, administrative offices, drainage improvement (i.e., swales, pipes, and culverts), stormwater wet pond, and car and semi-trailer parking areas (see Grading Plan under separate cover).

Stormwater management and sediment and erosion control measures include construction of collection devices (stormwater collection system, and stabilized grassed swales), temporary sediment traps, wet pond, outlet control riser, and discharge pipe outfall.

During site development, appropriate erosion and sediment control procedures will be followed to control erosion from disturbed areas. An Erosion and Sediment Control Plan will be submitted to NC DENR – Land Quality prior to construction.

### **4.0 BASIS OF DESIGN**

NC Solid Waste Management design criteria require stormwater control, and erosion and sediment control, be designed for the 25-year, 24-hour storm recurrent event. The City requires that stormwater control be designed to pre- vs. post-development rates for the 2- and 10-year, 24-hour storm recurrent events, and also requires the design for removal of Total Suspended Solids (TSS) be designed for 85 percent efficiency.

Establishment of the water quality (WQ) volume to be treated from the first 1-inch rainfall is required. This treatment includes the detention of the WQ that will be released during a 2- to 5-day period after the event.

A brief summary of regulatory criteria from the City Stormwater Drainage Manual and the NC DENR Solid Waste Regulations, include the following:

- Controlling pre- to post-development runoff rates for 2-, 10-, and 25-year reoccurrence storm events.
- Providing for 85-percent efficiency of TSS removal standards from runoff.
- Controlling 1-inch rainfall with timed release.
- Utilization of a wet pond design to provide for water quality treatment.
- Addressing any potential downstream impacts of a 100-year storm event.

## 5.0 HYDROLOGIC ANALYSES

### 5.1 Stormwater Runoff Determination Procedure

Stormwater peak runoff quantities were determined utilizing SCS hydrology methods TR-20 and TR-55. References included the USGS topographic maps, Guilford County (County) aerial mapping, and SCS soil survey mapping. Site hydrology was modeled utilizing Intelisolve Hydraflow Hydrograph 2004 software.

#### 5.1.1 Storm Precipitation

Hydrograph generation utilizes SCS 24-hour storm precipitation for the City.

Summary of SCS 24-hour Storm Precipitation (Inches)					
Location	Return Period				
	1-Year	2-Year	10-Year	25-Year	100-Year
Greensboro NC	3.0	3.5	5.5	6.0	7.5

#### 5.1.2 Drainage Basin Delineation

Drainage from off-site areas to the perimeter drainage ditches was investigated and it was determined that minimal runoff onto the site occurred from off-site (see Figures 4 and 5 and Calculations 7 and 9).

The developed site area size, which is located in the drainage basin of the wet pond, is 7.49 acres. Stormwater runoff from this area is collected and routed to the proposed pond. This developed basin includes many subbasins, defined by location of new drain inlet structures. All impervious surfaces, on the project are located within this delineation. No off-site drainage from impervious surfaces flows into the wet pond drainage basin area.

All collected stormwater runoff is directed to the site outfall after being routed and treated by the water quality pond.

### **5.1.3 Soil Characteristics**

Soil conditions for proposed built-out conditions were considered in determination of stormwater runoff potential. Current on-site soils are comprised of Hydrologic Group C soils (see Figure 3).

The soil characteristics of existing drainage basins are detailed in Figure 3 and Calculation 8. Existing SCS Curve Numbers (CN) average CN-67.

The soil characteristics of Developed Drainage Basins are detailed in Figure 3 and Calculation 10. Developed SCS CN average CN-88.

### **5.1.4 Time of Concentration**

Hydrologic calculations for the sub-drainage areas of the basins were performed. Time of Concentration ( $T_c$ ) for each of the subbasins was made based on cumulative time for sheet flow, concentrated flow, and channelized flow travel times. Calculations 8 and 10 lists sheet and shallow concentrated flow lengths.

### **5.1.5 Runoff Conveyance**

Design was performed for the storm drain collection system for all collection improvements onsite. Design of the storm drain pipes was performed utilizing Hydraflow Storm Sewers 2000, by Intelisolve. Drainage design reports are presented in Calculation 15. RCP is used for all drainage piping.

## **5.2 Control of Stormwater Runoff**

Post-development stormwater flows were routed through the proposed pond. This routing was performed based on TR-20 routing criteria utilizing Hydraflow Hydrographs 2004 by Intelisolve.

The WQ pond is designed as a wet pond. Storage capacity for detention of inflows is provided by available storage above a normal pool elevation. The pond outlet control structure is designed to include a multi-stage riser. This control riser provides for retention of the 1 inch depth of runoff water quality volume, and the storage capacity for attenuation of post-development flows to pre-development flow rates (see Calculation 14g).

The outlet riser is a typical square precast concrete riser with a set elevation of the top inflow edge. At this location a trash screen is detailed. A multi-stage weir is set on two sides at a slightly lower elevation for a passage of more frequent storm events. The actual design water surface elevations for each event are detailed on the plans and listed with the pre- and post-development peak flow comparisons table. The outlet riser is augmented with a low-flow orifice pipe at the permanent pool elevation and two trash skimmer baffles. A discharge pipe is to be installed from the riser to the outfall location of the site. This outfall will be improved with inclusion of a headwall and a stone energy dissipater.

The pond shape includes a 10 foot wide bench just above the permanent pool elevation. The pond also includes establishment of a Municipal Utility Easement designation around the perimeter of the pond. Maintenance access is via the Facility access drives.

The emergency overflow weir is a sag in the adjacent service drive. This road section is modeled as the overflow relief for major storm events, the 100-year recurrent storm event. A 1-foot minimum freeboard is provided for above the 100-year storm elevation in the pond. The basin is designed for controlled passage of the 2-, 10-, 25- and 100-year storm events.

Development of four drainage basins was accomplished for the existing, pre-development site. The basins are referred to as Pre-SC 1, 2, 3, and 4. The four basins were re-identified, in preparation of the Hydrology Model, as Hydrographs 1, 2, 3, and 4. The attached Hydrographs Model Report includes both the designation and the description (see Calculation 14).

Development of several drainage basins was accomplished for the developed site. The basins are referred to as Post-SC 1 through Post-SC 14. The basins, in addition to combinations and reaches, were re-identified in the Hydrology Model, as Hydrographs 5 through 32. The attached Hydrographs Model Report includes both the designation and the description. A summary of the Hydrograph data, including SCS input data, is attached and detail results are included for 10-year storm event recurrences (see Calculations 14a and 14g).

A summary of the pre- and post-development flow rates, of the combined pond outfall and peripheral site areas as listed in Calculation 13, are as follows.

#### Summary of StormWater Peak Runoff Quantities

Storm Reoccurrence Event (Year)	Peak Flow (Qpk CFS)		Change Pre/Post (Percent)	Elevation of Water Quality Pond (MSL)
	Pre- Development (HYD 34)	Post- Development (HYD 33)		
1	4.91	3.82	-22%	903.96
2	7.87	7.76	-1%	904.25
10	22.71	19.45	-14%	905.58
25	26.87	20.72	-23%	905.89
100	39.99	39.83	0%	906.61

Review of the comparison flow rates indicates that the post-development flow rates are comparably equal to the pre-development rates, and the design for attenuated flow quantities conforms to the stated objectives. Also, potential for downstream impacts is avoided as peak flow of the 100-year event is not greater in the developed condition.

### **5.3 Stormwater Quality Treatment Volume – Wet Pond BMP**

Use of the permanent Best Management Practices (BMPs) (wet pond) provides primary treatment of stormwater runoff. This BMP is designed to provide treatment during periods of construction and permanent operation. Efficiencies for the treatment areas have been calculated using the principle of sedimentation treatment process. Permanent water surface elevation was established to provide a minimum of a 7-foot wet pond depth to assist with treatment design.

The proposed pond has a permanent water quality wet pond BMP, which is sized to provide 85 percent removal efficiency of TSS. The 85 percent TSS removal efficiency goal was achieved through sizing the pond surface areas and control of the discharge rate.

Approximately 7.49 acres, drain to the pond. This area includes 4.38 acres of impervious area. The pond is sized for 59 percent impervious. The site property, as a whole, is 46 percent impervious (see Calculation 6). The surface area needed for the wet pond is 4,242 SF; however, 9,099 sf is provided.

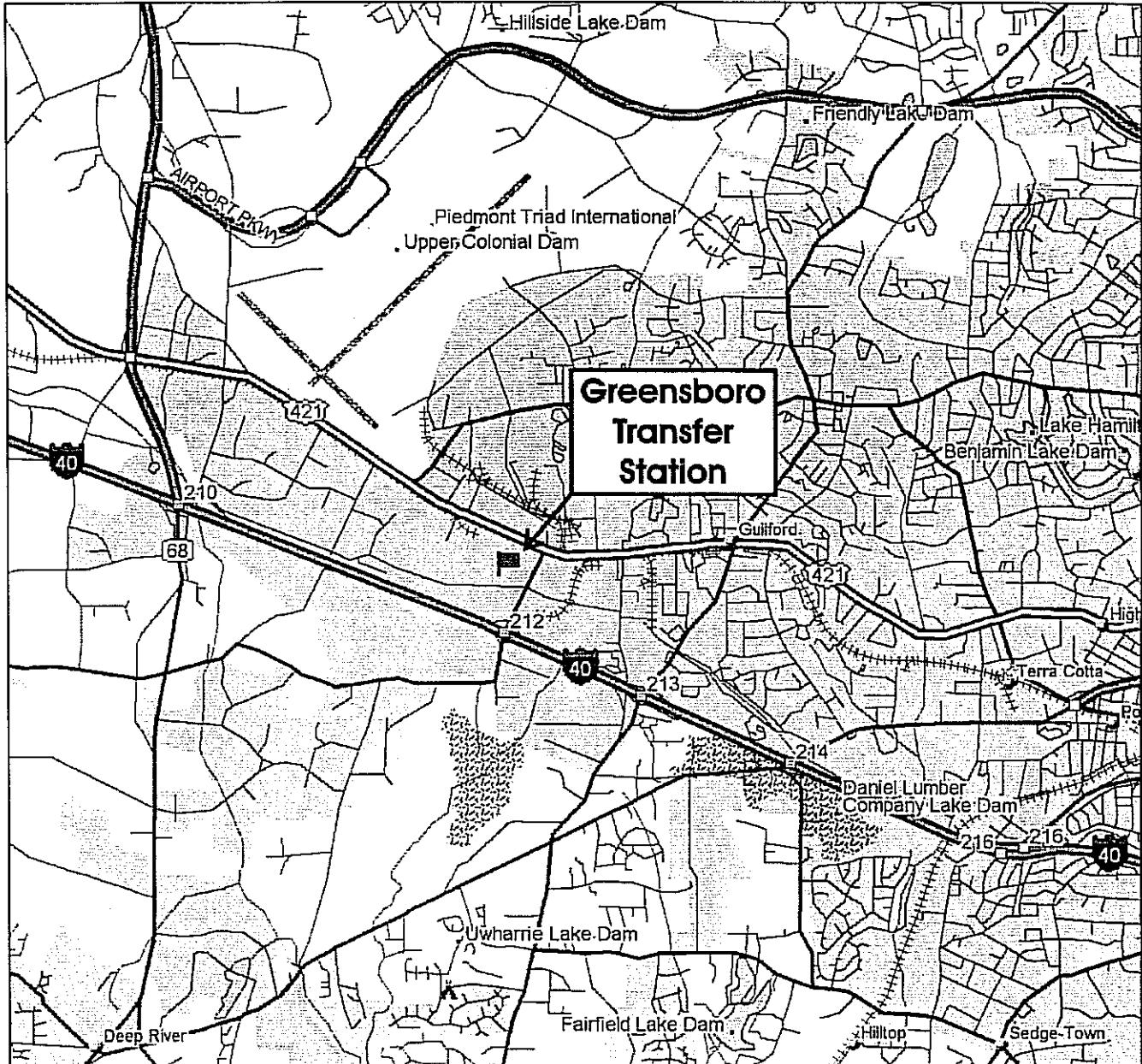
The water quality volume for a 1-inch precipitation event is 15,677 cubic feet. This volume is provided for in the pond. The depth is represented as 1.58 feet. A drawdown time of 2.1 days is provided for with utilization of a 2 inch diameter low-flow orifice.

Calculations for sizing of wet pond treatment and drawdown rates are summarized in the Wet Pond WQ attachment (see Calculation 11).

**FIGURES**  
**STORMWATER MANAGEMENT**

---

## **Site Location Map**



**HDR**

HDR Engineering, Inc.  
of the Carolinas

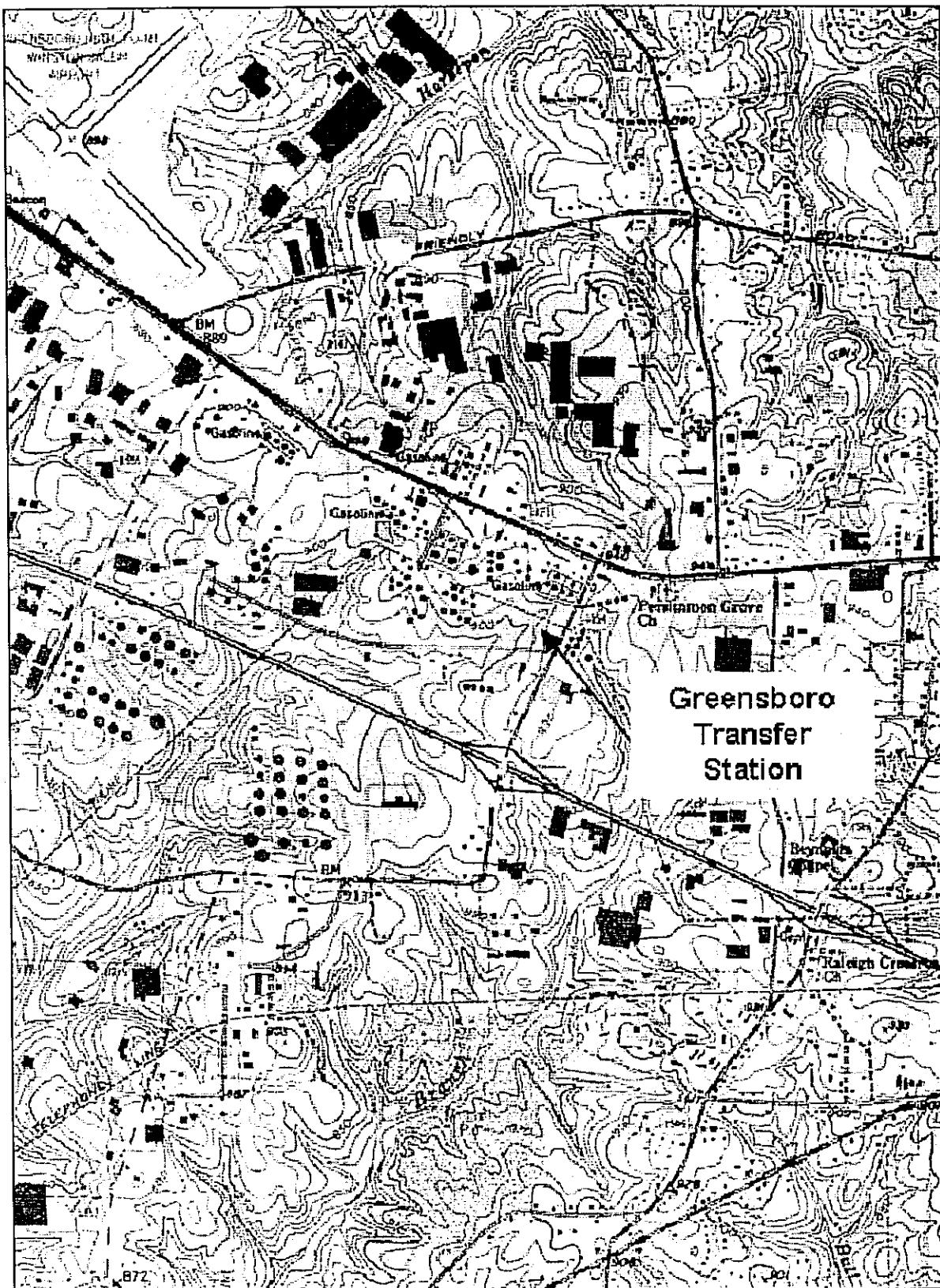
Suite 1400  
128 S. Tryon Street  
Charlotte, NC 28202-5009  
(704) 338-6700

## TRANSFER STATION SITE LOCATION MAP

Figure 1

Date  
March 2004

# **Topography Plan**



Source: USGS Quadrangle — Guilford, NC, 1951, Photo Revised 1994



HDR Engineering, Inc.  
of the Carolinas

Suite 1400  
128 S. Tryon Street  
Charlotte, NC 28202-5009  
(704) 338-6700

## TRANSFER STATION TOPOGRAPHY PLAN

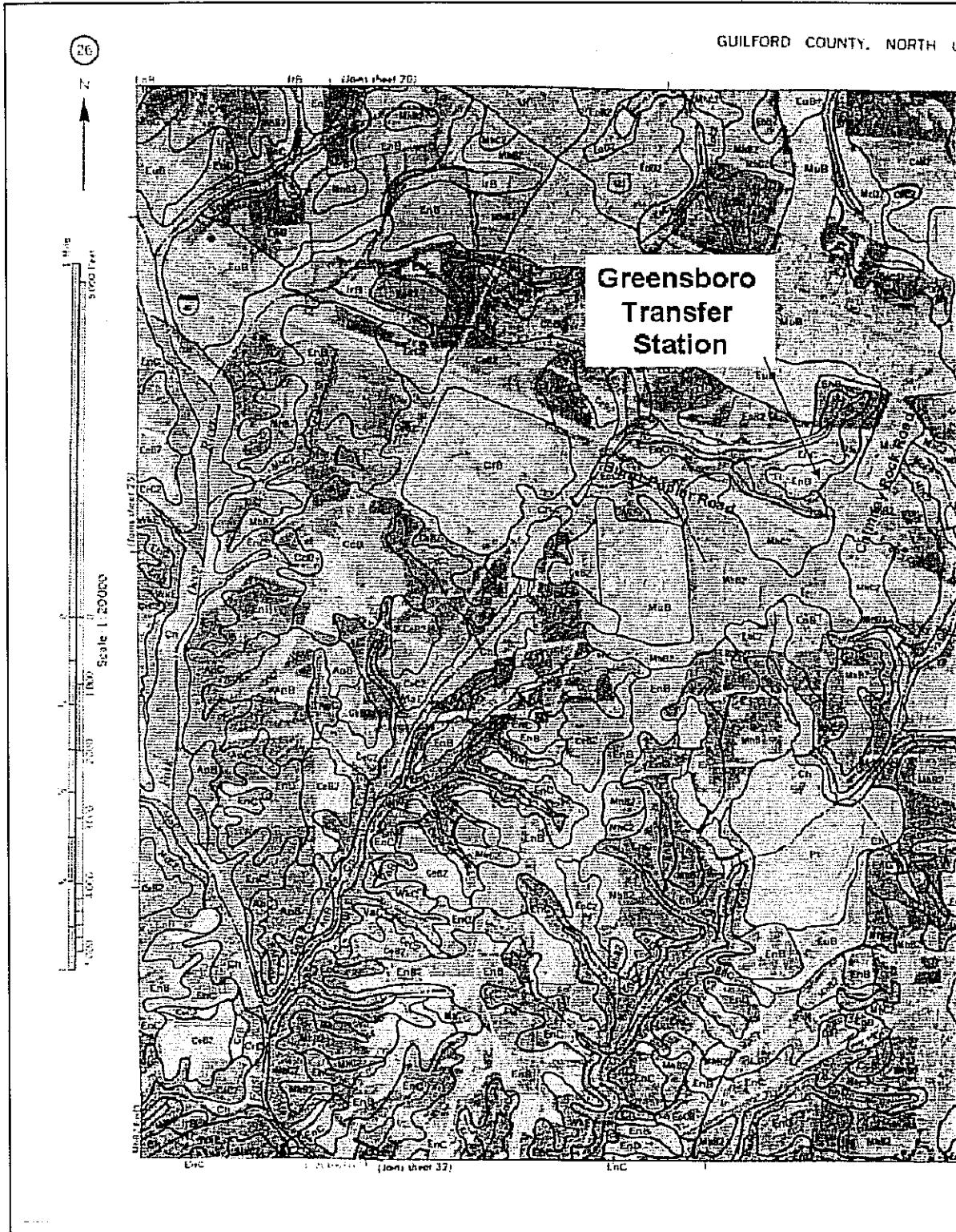
Figure

2

Date

March 2004

# **SCS Soils Map**



Source: Guilford County Soil Survey, 1977

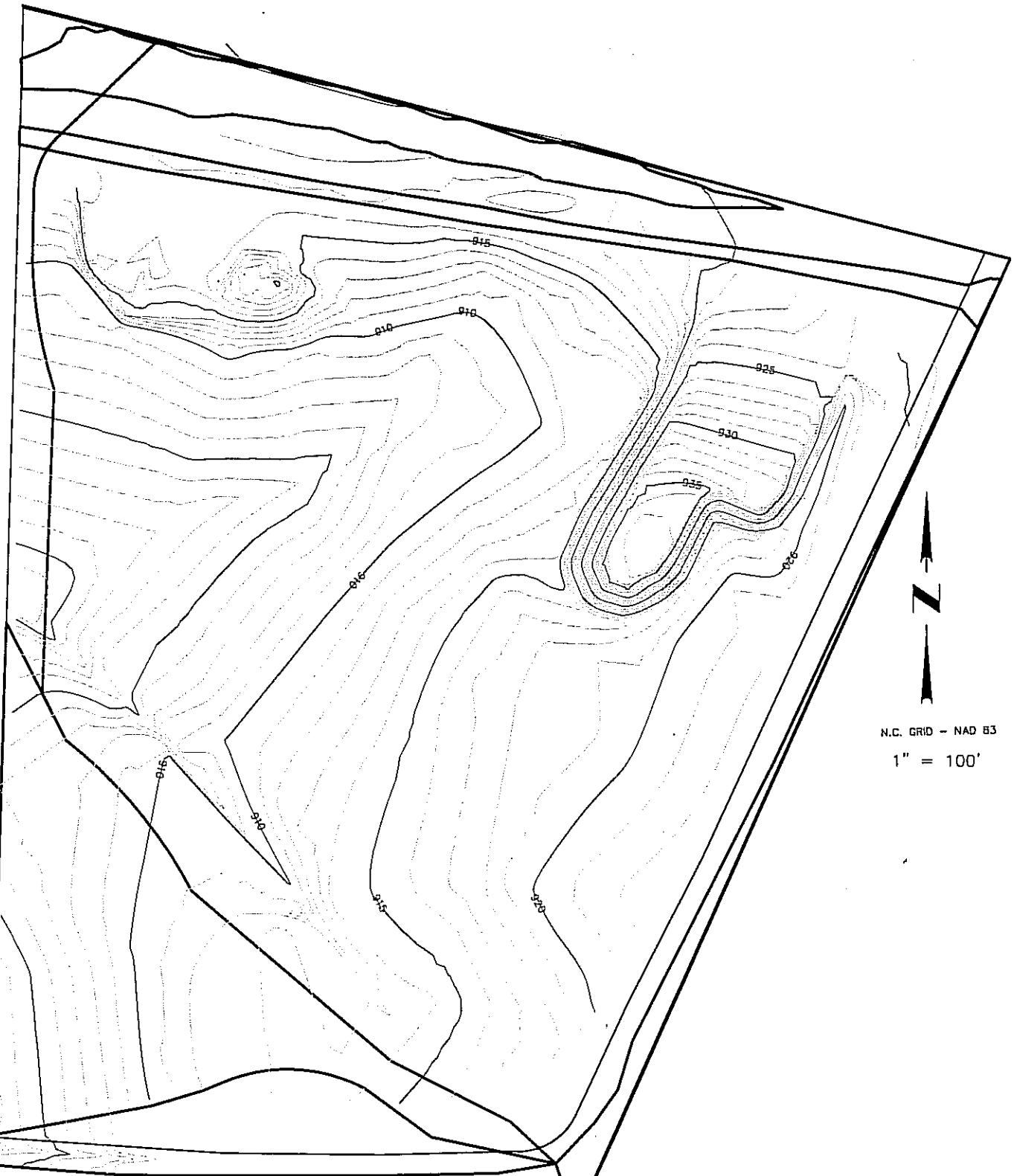
**HDR**  
Engineering, Inc.  
of the Carolinas  
Suite 1400  
128 S. Tryon Street  
Charlotte, NC 28202-5009  
(704) 338-6700

## TRANSFER STATION

# SCS SOILS MAP

Figure 3  
Date  
March 2004

## **Existing Drainage Areas**



HDR Engineering, Inc.

of the Carolinas

Suite 1400  
1228 S. Tryon Street  
Charlotte, NC 28202-5009  
(704) 338-6700

## TRANSFER STATION

## EXISTING DRAINAGE AREA

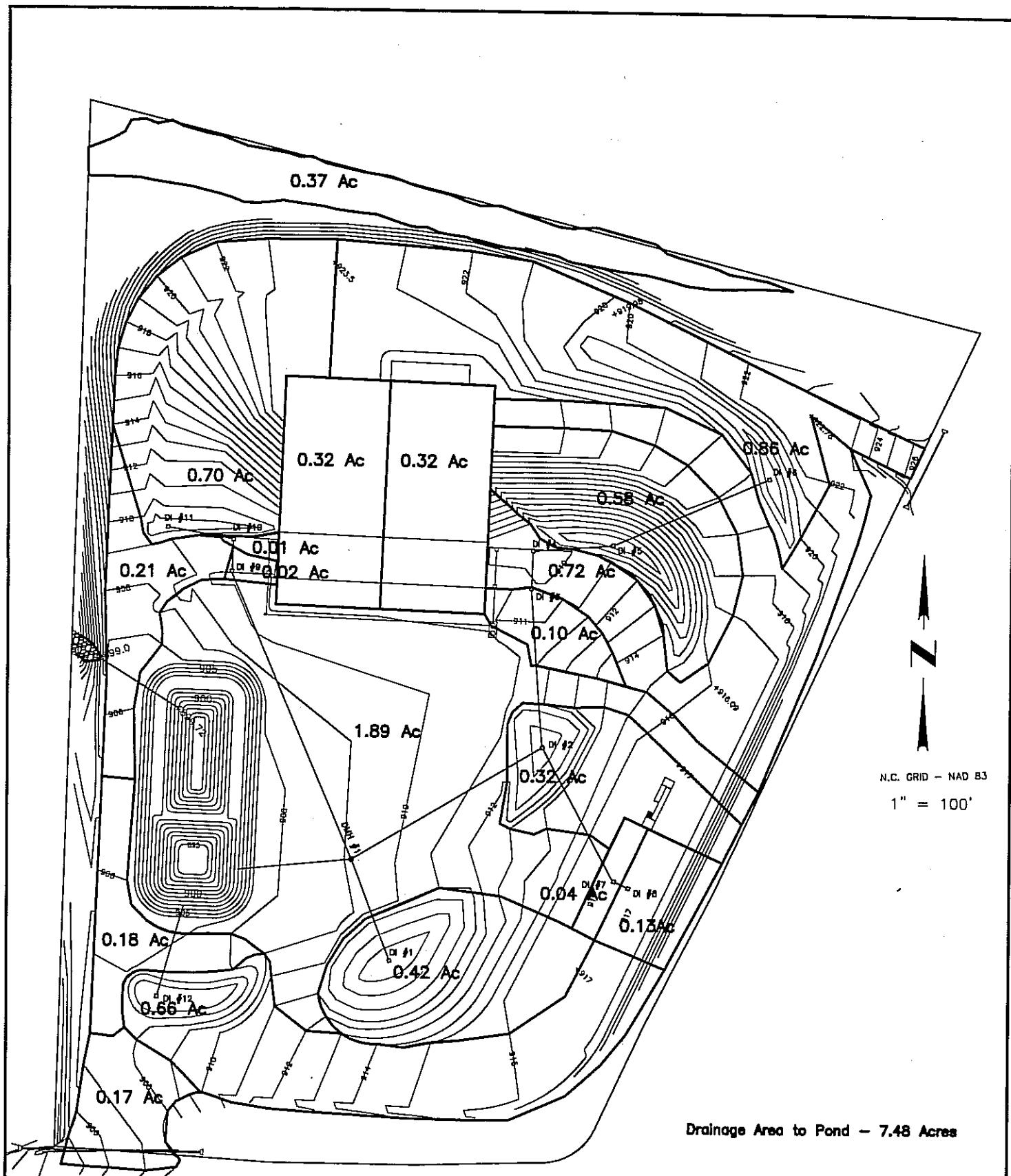
Figure

4

Date

March 2004

## **Proposed Drainage Areas**



**HDR**

HDR Engineering, Inc.  
of the Carolinas

Suite 1400  
128 S. Tryon Street  
Charlotte, NC 28202-5009  
(704) 338-6700

## TRANSFER STATION

### PROPOSED DRAINAGE AREA

Figure  
**5**

Date  
March 2004

**CALCULATIONS**  
**STORMWATER MANAGEMENT**

---

## **Land Use Coverage**

## Land Use Coverage

06770-2707  
GHetzler  
10/6/03

Table of Land Use Coverage

	Pre-Development		Post-Development	
	Area (Ac)	Percent (%)	Area (Ac)	Percent (%)
Open Space/ Meadow	-	0%		0%
Scrub/Shrub	8.69	93%		0%
Wooded	0.70	7%		0%
Pavement, Walks	-	0%	3.69	39%
Roofs	-	0%	0.63	7%
Lawn		0%	4.56	49%
Pond		0%	0.51	5%
Total	9.39	100%	9.39	100%
<b>Total Impervious Area - Pavement, Walks, Roofs</b>	<b>0.00</b>	<b>0%</b>	<b>4.32</b>	<b>46%</b>

## **Predevelopment Drainage Areas**

## Pre-Development Drainage Areas

06770-2707  
Ghetzler  
10/6/03

Pre-Development Drainage Areas												
Sub Catchment Area (SC)	Pavement, Walks						Lawn				Total Ac	Total %
	Open Space/Meadow	Scrub/Shrub	Wooded	Decks	(Ac)	(%)	(Ac)	(%)	(Ac)	(%)		
SC 1	-	0%	7.51	92%	0.30	4%	0.32	4%	-	0%	-	0%
SC 2	-	0%	0.97	86%	0.16	0.14	-	-	-	-	-	1.13
SC 3	-	-	0.29	0.49	0.12	0.20	0.19	0.31	-	-	-	0.61
SC 4	-	-	0.24	0.94	0.01	0.03	0.01	0.03	-	-	-	0.25
All Basins	-	0%	9.01	89%	0.58	6%	0.52	5%	-	0%	-	10.11
												100%
												0.33
												66.97

## **Predevelopment Flow Lengths**

## Pre-Development Flow Lengths

06770-2707  
GHetzler  
10/6/03

Sub Catchmen t Area (SC)	Sheet Flow (Length 'A')		Shallow Concentrated Flow (Length 'B')		Concentrated Swale (Length 'C')	
	(FT)	Gradient (%)	Unpaved (FT)	Paved (FT)	(FT)	Gradient (%)
SC 1	327.98		350.84			
SC 2	212.65					
SC 3	159.84		225.35			
SC 4	211.36		177.38			

## **Post-development Drainage Areas**

### Post-Development Drainage Areas

Post-Development Drainage Areas																		
Sub Catchment Area (SC)	Drop Inlet #	Open Space/Meadow			Scrub/Shrub			Wooded			Pavement/Walks							
		(Ac)	(%)	(Ac)	(%)	(Ac)	(%)	(Ac)	(%)	(Ac)	(%)	(Ac)	(%)					
SC 1	Pond	-	0%	-	0%	-	0%	-	0%	-	0%	0.41	100%					
SC 2	Parking RunOff	-	0%	-	0%	-	0%	-	0%	-	0%	1.48	100%					
SC 4	DI-2	-	0%	-	0%	-	0%	-	0%	-	0%	0.32	100%					
SC 5	DI-1	-	0%	-	0%	-	0%	-	0%	-	0%	0.42	100%					
SC 6	DI-7, 8	-	0%	-	0%	-	0%	-	0%	-	0%	0.17	100%					
SC 7a,7b,7c	DI-3,4,5	-	-	-	-	-	0.48	34%	-	0.93	0.66	-	1.40	100%				
SC 8	DI-6	-	-	-	-	-	0.47	54%	-	0.39	0.46	-	0.86	100%				
SC 9	DI-9,10A,11	-	-	-	-	-	0.33	0.45	-	0.41	0.55	-	0.73	1.00				
SC 10	DI-4,10	Road	-	-	-	-	0.36	93%	-	0.03	0.07	-	0.54	1.00				
SC 11A&B	DI-12	RunOff	-	-	-	-	0.46	70%	-	0.20	0.30	-	0.66	100%				
SC 12	Chimney Rock	-	-	-	-	-	0.09	12%	-	0.63	0.88	-	0.71	100%				
SC 13	Burnt Poplar	-	-	-	-	-	0.30	39%	-	0.48	0.61	-	0.78	100%				
SC 14	North Area	-	-	-	-	-	0.47	100%	-	-	-	-	0.47	100%				
Totals		-	0%	-	0%	-	4.60	49%	0.64	7%	3.80	40%	0.41	4%	9.45	100%	0.67	88.34

## **Post-development Flow Lengths**

# Post-Development Flow Lengths

06770-2707

GHetzler

10/6/03

Sub Catchment Area (SC)	Sheet Flow (Length 'A')		Shallow Concentrated Flow (Length 'B')		Concentrated Swale (Length 'C')	
	(FT)	(%)	Unpaved (FT)	Paved (FT)	(FT)	(%)
SC 1						
SC 2	174.00					
SC 3	184.00					
SC 4	102.00					
SC 5	175.00		126.00			
SC 6	186.00		106.00			
SC 7	152.00					
SC 8	202.00					
SC 9	135.00					
SC 10	75.00					
SC 11	270.00		76.00			
SC 12	179.00		78.00			
SC 13	156.00		365.00			
SC 14	224.00		103.00			
SC 15	273.00		427.00			

## **Wet Pond WQ (Water Quality TSS Removal) and Pond Sediment Storage**

PROJECT: Greensboro Transfer Station  
 CLIENT: Greensboro NC

PROJ. NO.: 2707  
 DATE: 3/19/2004  
 DES. BY: GJH

**CALCULATE PERCENT OF IMPERVIOUS AREA DRAINING TO THE POND.**

WET POND WATERSHED AREA =	7.49	ACRES
WET POND WATERSHED IMPERVIOUS AREA =	4.38	ACRES
% IMPERVIOUS =	59%	

**PERMANENT POOL DEPTH.**

PERMANENT POOL ELEVATION =	902.0	FT
DESIGN PERMANENT POOL DEPTH =	7.0	FT

**DETERMINE THE PERMANENT POOL SURFACE AREA AS A PERCENTAGE OF THE DRAINAGE AREA (SA/DA) FROM THE CHART BELOW.**

**City of Greensboro Surface Area to Drainage Area Ratios**

**Water Quality Volume**

DEPTH	3	4	5	6	7	8	9.0+
IMP %							
10%	0.59	0.49	0.43	0.35	0.31	0.29	0.26
20%	1.0	0.8	0.7	0.6	0.5	0.5	0.4
30%	1.3	1.1	1.0	0.9	0.7	0.6	0.6
40%	1.7	1.4	1.3	1.0	0.9	0.8	0.8
50%	2.0	1.7	1.5	1.3	1.1	1.0	0.9
60%	2.4	2.0	1.7	1.5	1.3	1.2	0.1
70%	2.8	2.3	2.0	1.8	1.5	1.4	1.3

SA/DA PERCENTAGE FACTOR =	1.30	%
---------------------------	------	---

**DETERMINE THE REQUIRED SURFACE AREA OF THE PERMANENT POOL AND FOREBAY.**

POND SURFACE AREA REQUIRED =	4,242	FT <sup>2</sup>
FOREBAY SURFACE AREA REQUIRED =	848	FT <sup>2</sup>
POND SURFACE AREA PROVIDED =	9,099	FT <sup>2</sup>
FOREBAY SURFACE AREA PROVIDED =	4,000	FT <sup>2</sup>

**DETERMINE THE VOLUME TO BE CONTROLLED FROM THE 1" STORM.**

VOLUME REQUIRED = (DESIGN RAINFALL)(R<sub>v</sub>)(WATERSHED AREA)

DESIGN RAINFALL =	1.0 IN	Total Area
-------------------	--------	------------

R<sub>v</sub> = 0.05 + 0.009(I) WHERE I = PERCENT IMPERVIOUS (%)

R<sub>v</sub> = 0.58 IN/IN

WATERSHED AREA =	7.49	ACRES
------------------	------	-------

	1 inch - Total Area	
VOLUME REQUIRE D1- =	15,677	FT <sup>3</sup>

VOLUME PROVIDED-1- =	15,677	FT <sup>3</sup>	ELEV. =	903.39
----------------------	--------	-----------------	---------	--------

## DETERMINE THE STORAGE ELEVATION OF THE CONTROLLED 1" STORM VOLUME

STAGE (FT)	ELEV. (FT)	AREA (FT <sup>2</sup> )	VOLUME (FT <sup>3</sup> )	ACC. VOLUME (FT <sup>2</sup> )	Cumm Volume	WQ ELEV
0	895	1,009	0	0		
1	896	1,729	1,353	1,353		
2	897	2,638	2,168	3,520		
3	898	3,643	3,127	6,648		
4	899	4,802	4,209	10,857		
5	900	6,097	5,437	16,293		
6	901	7,527	6,799	23,093		
7	902	9,099	8,301	31,393	10,620	#DIV/0!
8	903	12,218	10,620	42,014	23,540	903.48
9	904	13,635	12,920	54,934	37,906	903.39
10	905	15,110	14,366	69,300	53,775	903.45
11	906	16,640	15,869	85,169	71,203	903.60
12	907	18,227	17,427	102,596		

Draw Down Time - Verify that time required to drawdown runoff volume is greater than 2 days.

Volume to Draw Down	15,677	CF	Pond Criteria, 1-inch Imp Runoff
Diameter of Proposed Low-flow Orifice	2.00	IN	Value chosen by designer
Total Elevation Head Above Orifice	1.4	FT	(Total Elevation Head Above Orifice)=(Storage Elevation at Required Volume)-(Elevation of Permanent Pool Surface)
Average Elevation Head Above Orifice	0.7	FT	(Average Elevation Head Above Orifice)=[(Storage Elevation at Required Volume)+(Elevation of Permanent Pool Surface)]/2-(Storage Elevation at Required Volume)
Cd, Coefficient of Discharge	0.6		Value chosen by designer
Q, Flowrate Through Low-flow Orifice	0.088	CFS	$Q=Cd \cdot (\pi) \cdot [(Diameter \text{ of Orifice}) \cdot (1 \text{ ft}/12 \text{ in})]^{2/4} \cdot [2 \cdot 32.2 \cdot (\text{Avege Head})]^{1/2}$
Drawdown Time for 1-inch Runoff	2.1	DAYS	(Drawdown Time)=(1" Runoff Volume)/Q*(1 day/86400 seconds)

## Greensboro Transfer Station

HDR Project # 6770-2707-018

**Determine Shape of Basin:**

Measure the area of the Basin using AutoCADD.

Calculate Volume of the Basin using Truncated Pyramid Method.

Elevation (ft)	Depth (ft)	Area (SF)	Volume (cf)	Cumulative Vol (cf)
895	0	501		
896	1	909	695	695
897	2	1425	1,157	1,852
898	3	1,977	1,693	3,546
899	4	2,619	2,290	5,836
900	5	3,333	2,969	8,805
901	6	4,119	3,719	12,524
902	7	5,099	4,600	17,124

20	895	0	508	
	896	1	820	658
	897	2	1,213	1,010
	898	3	1,666	1,434
	899	4	2,183	1,919
	900	5	2,764	2,468
	901	6	3,408	3,080
	902	7	4,000	10,568

STAGE (FT)	ELEV. (FT)	AREA (FT <sup>2</sup> )	VOLUME (FT <sup>3</sup> )	ACC. VOLUME (FT <sup>2</sup> )
0	895	1,009	0	0
1	896	1,729	1,353	1,353
2	897	2,638	2,168	3,520
3	898	3,643	3,127	6,648
4	899	4,802	4,209	10,857
5	900	6,097	5,437	16,293
6	901	7,527	6,799	23,093
7	902	9,099	8,301	31,393
8	903	12,218	10,620	42,014
9	904	13,635	12,920	54,934
10	905	15,110	14,366	69,300
11	906	16,640	15,869	85,169
12	907	18,227	17,427	102,596

Pond Sediment Storage		
Storage Volume (FT <sup>3</sup> ) to 3-FT Below NP (899-FT)	5,836	Fore Bay
	5,020	Main Bay
	10,856	Total
Drainage Area (DA) To Pond (AC)		7.72
Sediment Volume (FT <sup>3</sup> )= 0.125-IN x DA		3,503
Sediment Storage Volume is acceptable. Total volume can be stored in forebay, below maximum depth.		

## **Summary of Stormwater Peak Runoff Quantities**

**Summary of Storm Water Peak Runoff Quantities**

City of Greensboro Transfer Station				
Storm Reoccurrence Event (Year)	Peak Flow (Qpk CFS)		Change Pre/Post (Percent)	Elevation of Water Quality Pond (MSL)
	Pre Development (HYD 34)	Post Development (HYD 33)		
1	4.91	3.82	-22%	903.96
2	7.87	7.76	-1%	904.25
10	22.71	19.45	-14%	905.58
25	26.87	20.72	-23%	905.89
100	39.99	39.83	0%	906.61

## **Multi-Hydrograph Plot, Pre- vs. Post-Development for 1-, 2-, 10-, 25-, and 100-Year Events**

# Multi-Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

## Hyd. No. 31

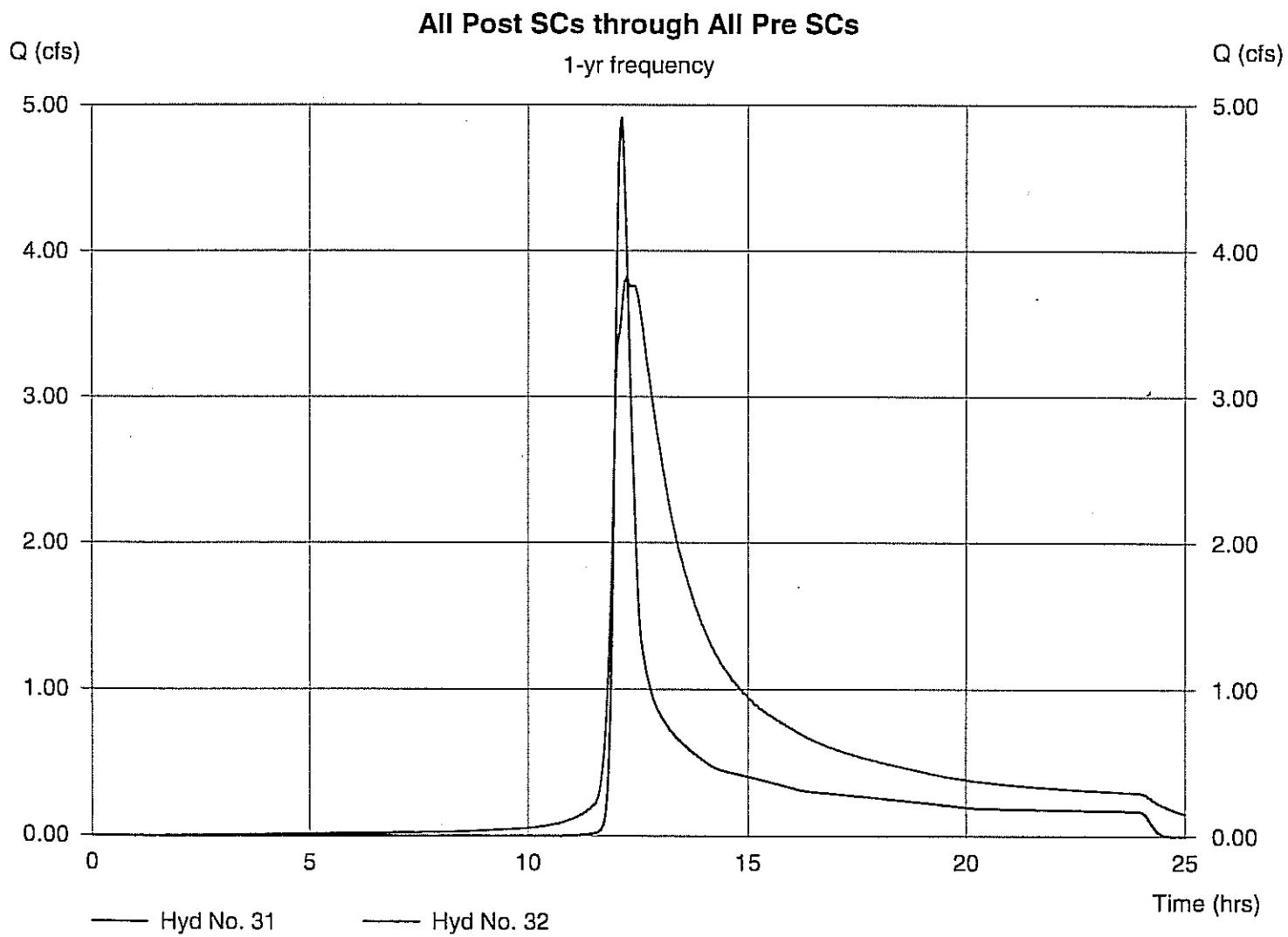
All Post SCs

Hydrograph type = Combine  
Peak discharge = 3.82 cfs  
Time to peak = 12.23 hrs  
Hyd. Volume = 1.319 acft

## Hyd. No. 32

All Pre SCs

Hydrograph type = Combine  
Peak discharge = 4.91 cfs  
Time to peak = 12.13 hrs  
Hyd. Volume = 0.487 acft



# Multi-Hydrograph Plot

Hydraflow Hydrographs by Intellisolve

## Hyd. No. 31

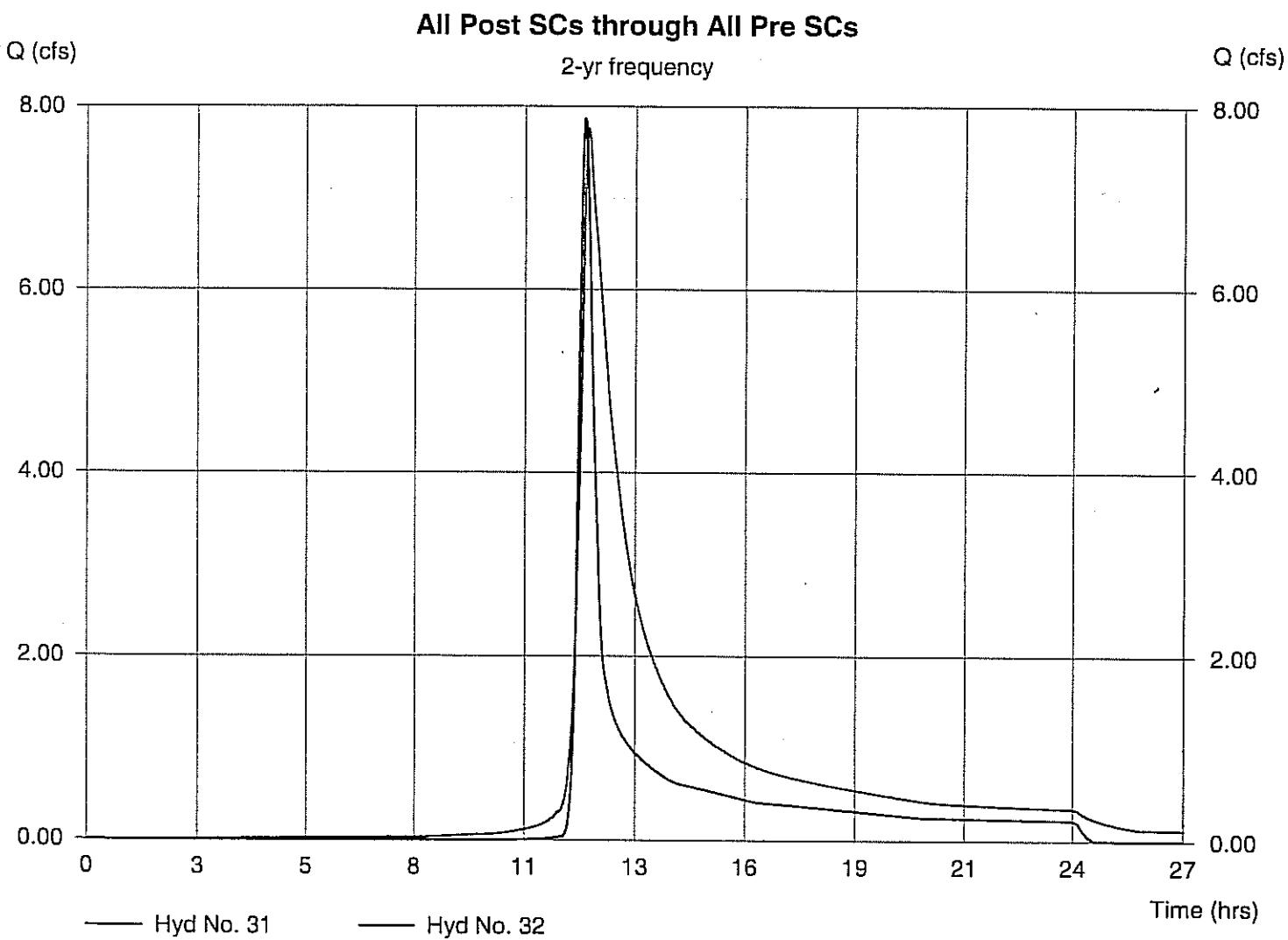
All Post SCs

Hydrograph type = Combine  
Peak discharge = 7.76 cfs  
Time to peak = 12.20 hrs  
Hyd. Volume = 1.661 acft

## Hyd. No. 32

All Pre SCs

Hydrograph type = Combine  
Peak discharge = 7.87 cfs  
Time to peak = 12.10 hrs  
Hyd. Volume = 0.709 acft



# Multi-Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

## Hyd. No. 31

All Post SCs

Hydrograph type = Combine  
Peak discharge = 19.45 cfs  
Time to peak = 12.07 hrs  
Hyd. Volume = 3.085 acft

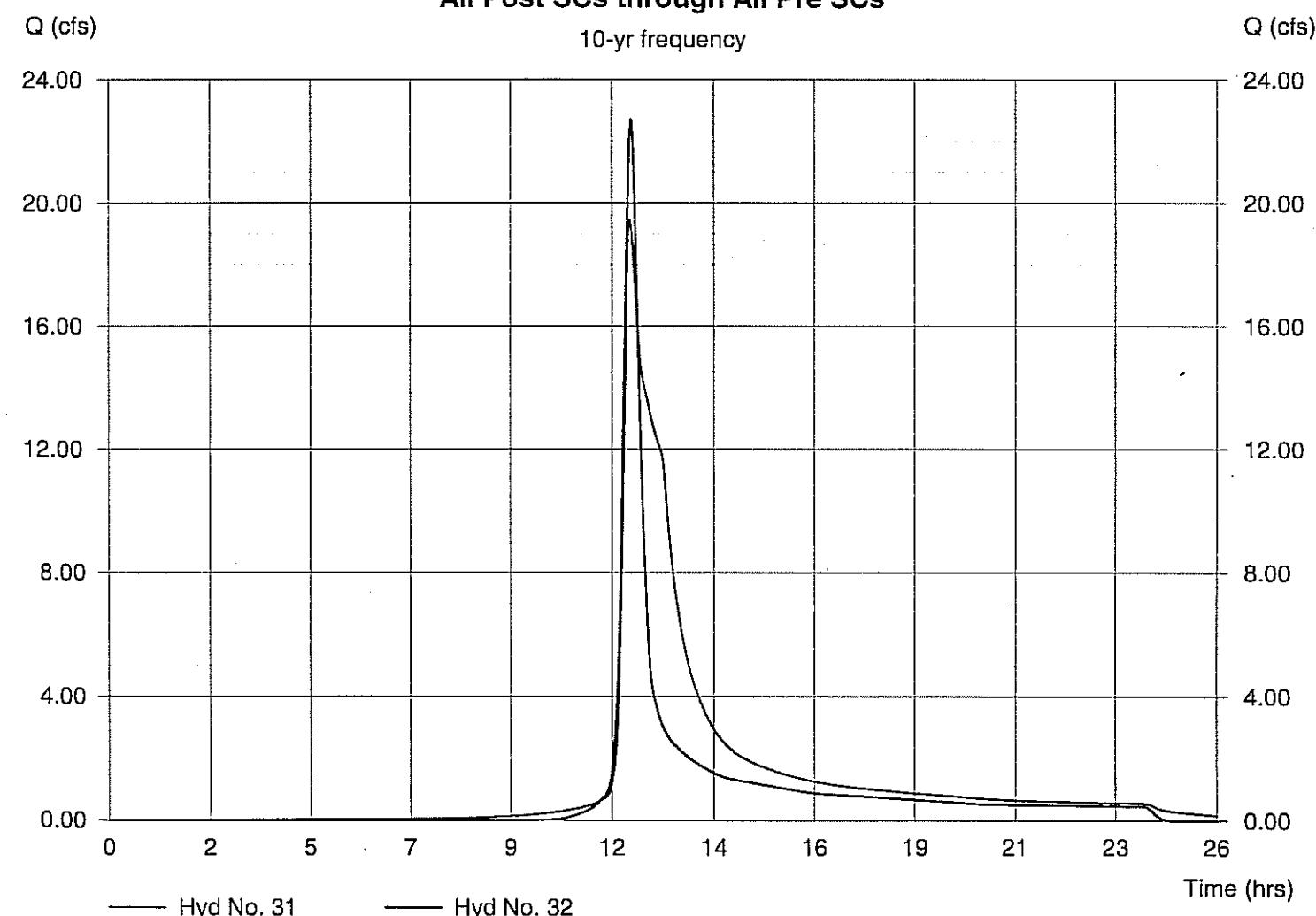
## Hyd. No. 32

All Pre SCs

Hydrograph type = Combine  
Peak discharge = 22.71 cfs  
Time to peak = 12.10 hrs  
Hyd. Volume = 1.811 acft

### All Post SCs through All Pre SCs

10-yr frequency



# Multi-Hydrograph Plot

Hydraflow Hydrographs by Intellisolve

## Hyd. No. 31

All Post SCs

Hydrograph type = Combine  
Peak discharge = 20.72 cfs  
Time to peak = 12.07 hrs  
Hyd. Volume = 3.449 acft

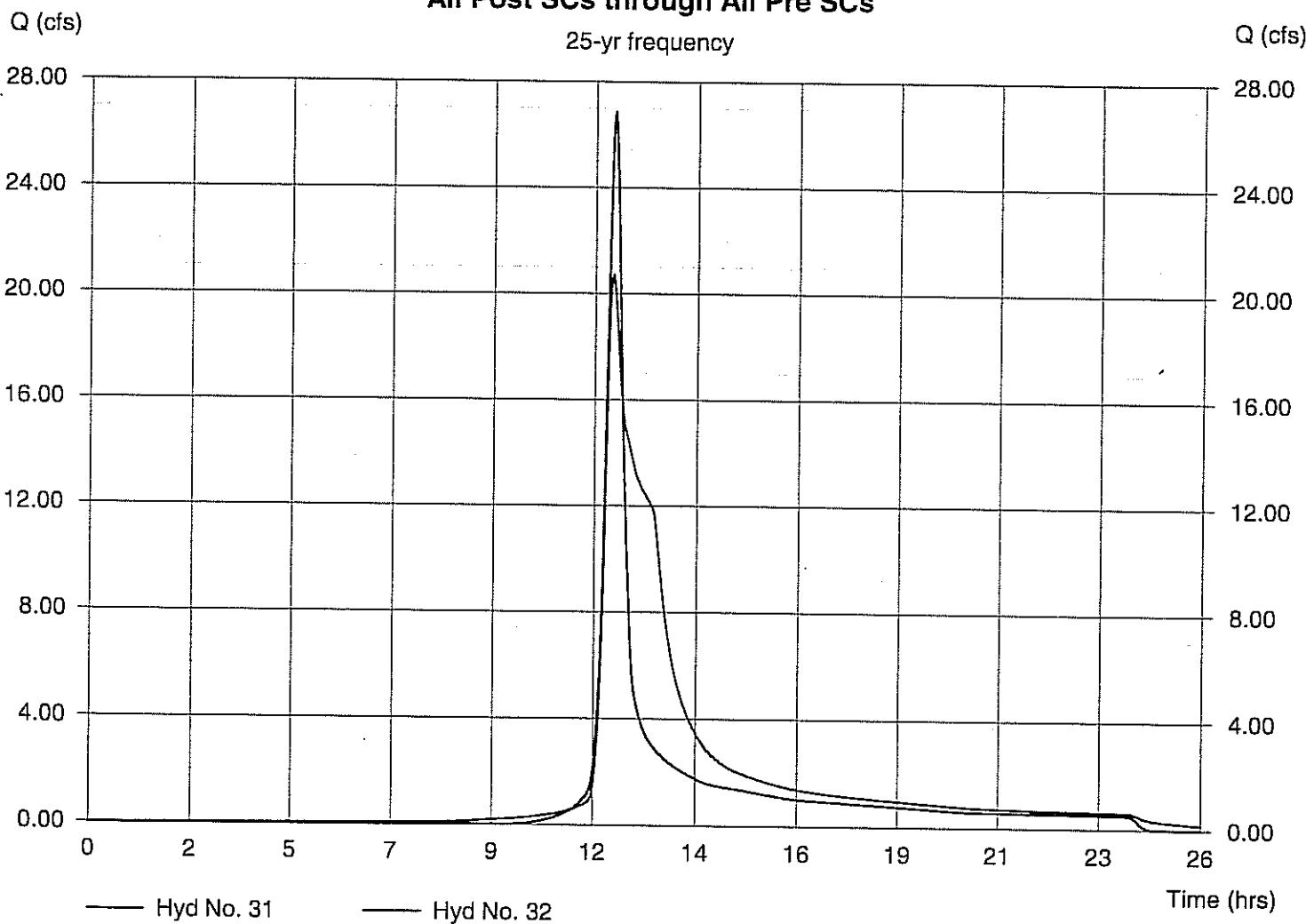
## Hyd. No. 32

All Pre SCs

Hydrograph type = Combine  
Peak discharge = 26.87 cfs  
Time to peak = 12.10 hrs  
Hyd. Volume = 2.124 acft

### All Post SCs through All Pre SCs

25-yr frequency



# Multi-Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

## Hyd. No. 31

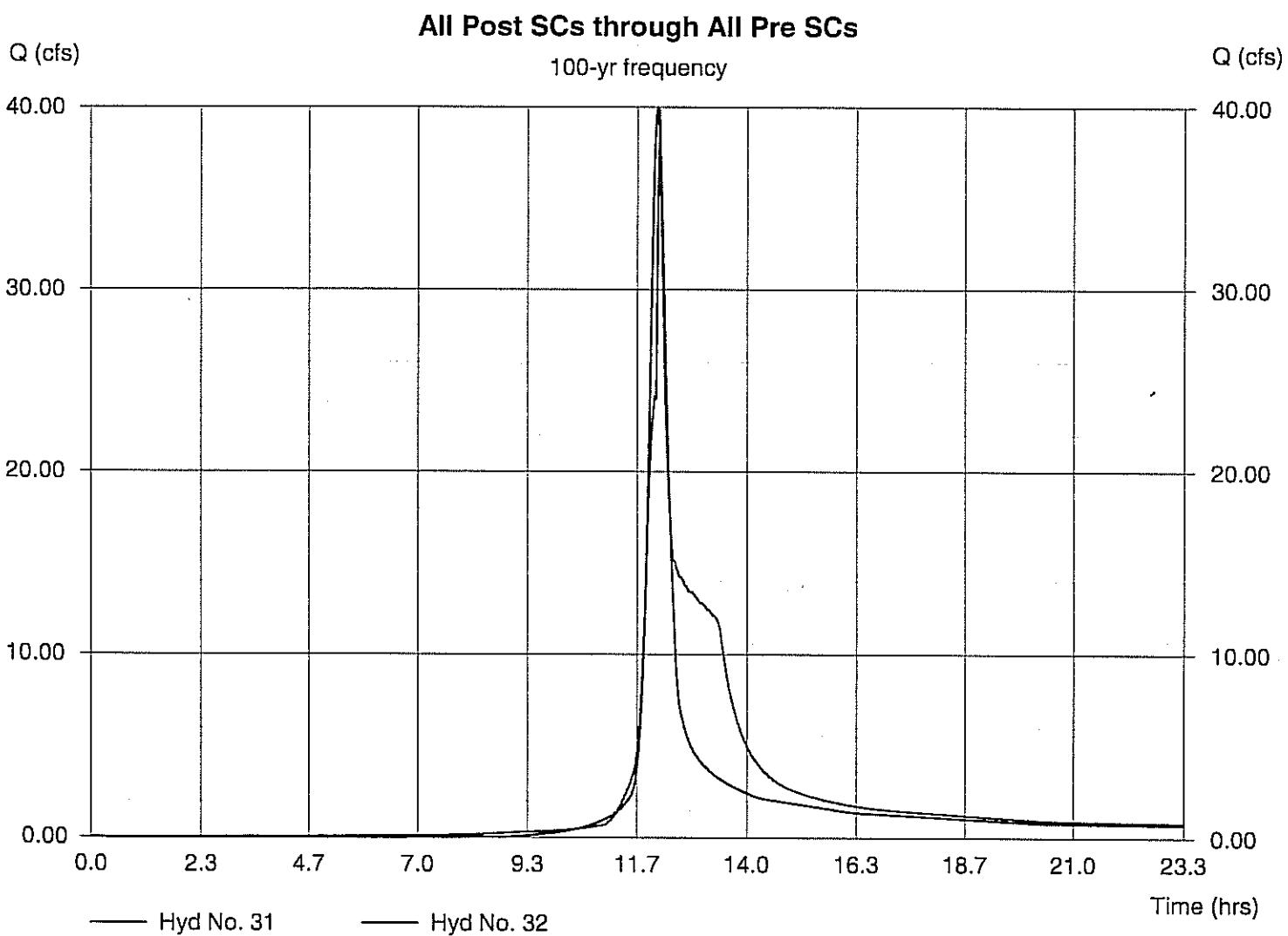
All Post SCs

Hydrograph type = Combine  
Peak discharge = 39.83 cfs  
Time to peak = 12.13 hrs  
Hyd. Volume = 4.555 acft

## Hyd. No. 32

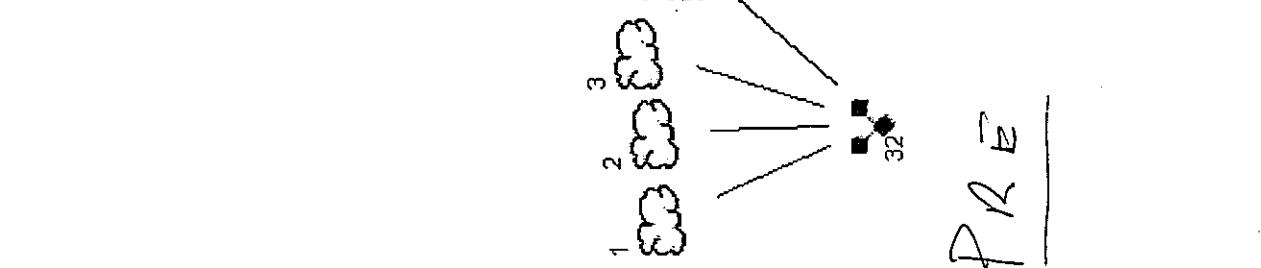
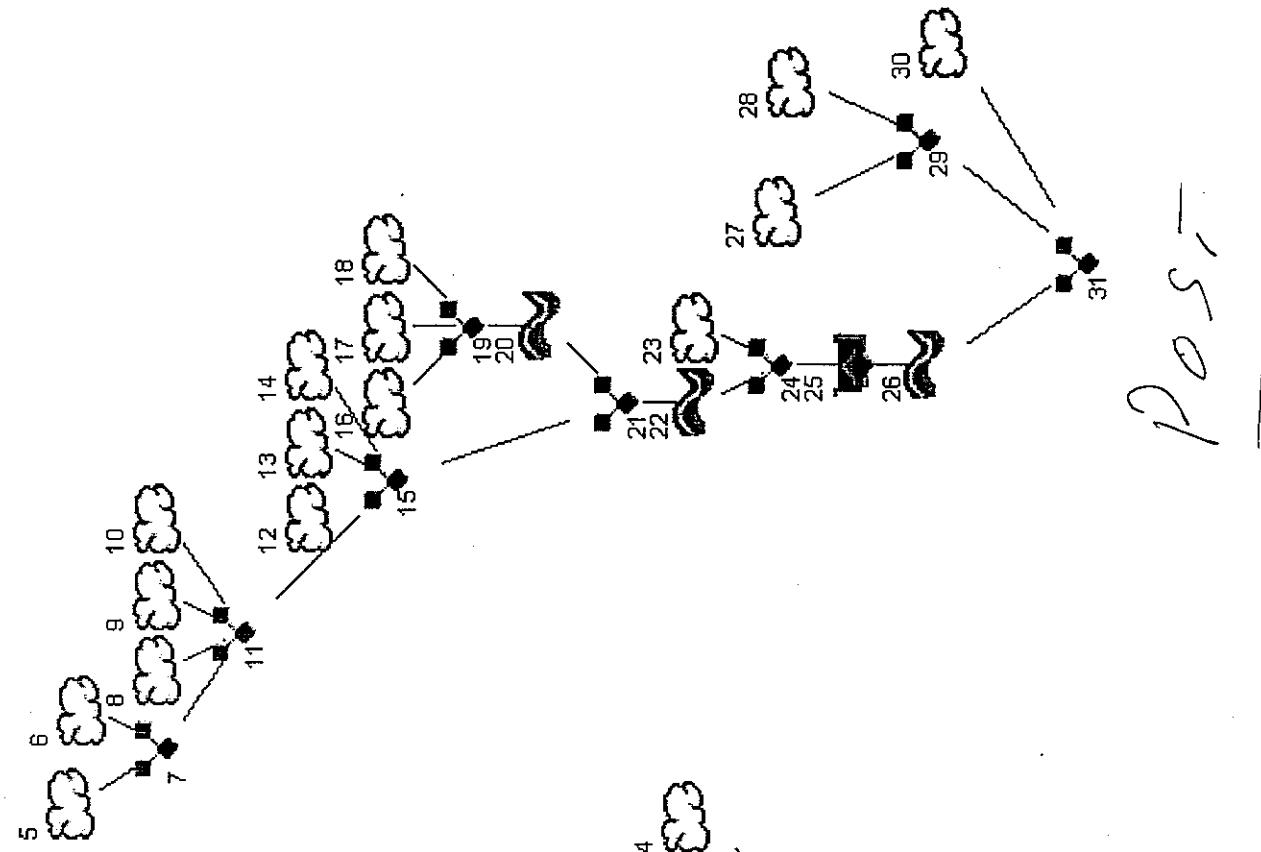
All Pre SCs

Hydrograph type = Combine  
Peak discharge = 39.99 cfs  
Time to peak = 12.10 hrs  
Hyd. Volume = 3.121 acft



# **Hydraflow Hydrographs Model Report**

## **Model Schematic**



Legend

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	SCS Runoff	Pre-SC 1
2	SCS Runoff	Pre-SC 2
3	SCS Runoff	Pre-SC 3
4	SCS Runoff	Pre-SC 4
5	SCS Runoff	Roof East - Post-SC 10B
6	SCS Runoff	DI-6 - Post-SC 8
7	Combine	Comb SC 8 and 10A
8	SCS Runoff	DI-3,4,5 - Post-SC 7a,7b,7c
9	SCS Runoff	DI-2 - Post-SC 4
10	SCS Runoff	DI-7,8 - Post-SC 6
11	Combine	Comb SC 4, 6, 7, 8, 10
12	SCS Runoff	DI-9,10A,11 - Post-SC 9
13	SCS Runoff	Roof West - Post-SC 10A
14	SCS Runoff	Road Runoff - Post-SC 11A&B
15	Combine	Comb SC 3,9,10,11
16	SCS Runoff	Parking RunOff - Post-SC 2
17	SCS Runoff	DI-1 - Post-SC 5
18	SCS Runoff	DI-12 - Post-SC 12
19	Combine	Comb SC 5 and SC 12
20	Reach	Reach from SC 5 and SC 12
21	Combine	Combine
22	Reach	Reach
23	SCS Runoff	Pond - Post-SC 1
24	Combine	Combine
25	Reservoir	Water Quality Pond
26	Reach	WQ Pond Outfall
27	SCS Runoff	Post-SC 13
28	SCS Runoff	Post-SC 14
29	Combine	Burnt Poplar Drive Culvert
30	SCS Runoff	North Area - Post-SC 15
31	Combine	All Post SCs
32	Combine	All Pre SCs

## **Table of Contents – 10-Year Reports**

# Table of Contents

032404 FINAL Trns Sta Hydrologic Model 6.gpw

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

## Hydrograph Return Period Recap ..... 1

### 10 - Year

Summary Report .....	3
Hydrograph Reports .....	5
Hydrograph No. 1, SCS Runoff, Pre-SC 1 .....	5
Hydrograph No. 2, SCS Runoff, Pre-SC 2 .....	6
Hydrograph No. 3, SCS Runoff, Pre-SC 3 .....	7
Hydrograph No. 4, SCS Runoff, Pre-SC 4 .....	8
Hydrograph No. 5, SCS Runoff, Roof East - Post-SC 10B .....	9
Hydrograph No. 6, SCS Runoff, DI-6 - Post-SC 8 .....	10
Hydrograph No. 7, Combine, Comb SC 8 and 10A .....	11
Hydrograph No. 8, SCS Runoff, DI-3,4, 5 - Post-SC 7a,7b, 7c .....	12
Hydrograph No. 9, SCS Runoff, DI-2 - Post-SC 4 .....	13
Hydrograph No. 10, SCS Runoff, DI-7, 8 - Post-SC 6 .....	14
Hydrograph No. 11, Combine, Comb SC 4, 6, 7, 8, 10 .....	15
Hydrograph No. 12, SCS Runoff, DI-9,10A,11 - Post-SC 9 .....	16
Hydrograph No. 13, SCS Runoff, Roof West - Post-SC 10A .....	17
Hydrograph No. 14, SCS Runoff, Road Runoff - Post-SC 11A&B .....	18
Hydrograph No. 15, Combine, Comb SC 3,9,10,11 .....	19
Hydrograph No. 16, SCS Runoff, Paking RunOff - Post-SC 2 .....	20
Hydrograph No. 17, SCS Runoff, DI-1 - Post-SC 5 .....	21
Hydrograph No. 18, SCS Runoff, DI-12 - Post-SC 12 .....	22
Hydrograph No. 19, Combine, Comb SC 5 and SC 12 .....	23
Hydrograph No. 20, Reach, Reach from SC 5 and SC 12 .....	24
Hydrograph No. 21, Combine, Combine .....	25
Hydrograph No. 22, Reach, Reach .....	26
Hydrograph No. 23, SCS Runoff, Pond - Post-SC 1 .....	27
Hydrograph No. 24, Combine, Combine .....	28
Hydrograph No. 25, Reservoir, Water Quality Pond .....	29
Pond Report .....	30
Hydrograph No. 26, Reach, WQ Pond Outfall .....	31
Hydrograph No. 27, SCS Runoff, Post-SC 13 .....	32
Hydrograph No. 28, SCS Runoff, Post-SC 14 .....	33
Hydrograph No. 29, Combine, Burnt Poplar Drive Culvert .....	34
Hydrograph No. 30, SCS Runoff, North Area - Post-SC 15 .....	35
Hydrograph No. 31, Combine, All Post SCs .....	36
Hydrograph No. 32, Combine, All Pre SCs .....	37

# Table of Contents

032404 FINAL Trns Sta Hydrologic Model 6.gpw

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 6:14 PM

## 1 - Year

<b>Hydrograph Reports .....</b>	<b>38</b>
Hydrograph No. 25, Reservoir, Water Quality Pond .....	38

## 2 - Year

<b>Hydrograph Reports .....</b>	<b>39</b>
Hydrograph No. 25, Reservoir, Water Quality Pond .....	39

## 10 - Year

<b>Hydrograph Reports .....</b>	<b>40</b>
Hydrograph No. 25, Reservoir, Water Quality Pond .....	40

## 25 - Year

<b>Hydrograph Reports .....</b>	<b>41</b>
Hydrograph No. 25, Reservoir, Water Quality Pond .....	41

## 100 - Year

<b>Hydrograph Reports .....</b>	<b>42</b>
Hydrograph No. 25, Reservoir, Water Quality Pond .....	42

## **Hydrograph Return Period Recap 1-, 2-, 10-, 25-, and 100-Year Events**

# Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
1	SCS Runoff	—	3.61	5.93	—	—	17.49	20.74	—	31.08	Pre-SC 1
2	SCS Runoff	—	0.63	1.01	—	—	2.89	3.43	—	5.12	Pre-SC 2
3	SCS Runoff	—	0.75	1.03	—	—	2.27	2.60	—	3.60	Pre-SC 3
4	SCS Runoff	—	0.14	0.22	—	—	0.64	0.76	—	1.13	Pre-SC 4
5	SCS Runoff	—	1.14	1.33	—	—	2.11	2.30	—	2.88	Roof East - Post-SC 10B
6	SCS Runoff	—	1.27	1.60	—	—	2.92	3.25	—	4.24	DI-6 - Post-SC 8
7	Combine	5, 6	2.02	2.45	—	—	4.23	4.67	—	6.01	Comb SC 8 and 10A
8	SCS Runoff	—	3.65	4.67	—	—	8.86	9.92	—	13.11	DI-3,4, 5 - Post-SC 7a,7b, 7c
9	SCS Runoff	—	0.58	0.78	—	—	1.64	1.86	—	2.55	DI-2 - Post-SC 4
10	SCS Runoff	—	0.37	0.48	—	—	0.94	1.06	—	1.41	DI-7, 8 - Post-SC 6
11	Combine	7, 8, 9, 10	6.45	8.14	—	—	15.14	16.90	—	22.22	Comb SC 4, 6, 7, 8, 10
12	SCS Runoff	—	1.60	2.04	—	—	3.87	4.34	—	5.73	DI-9,10A,11 - Post-SC 9
13	SCS Runoff	—	1.14	1.33	—	—	2.11	2.30	—	2.88	Roof West - Post-SC 10A
14	SCS Runoff	—	1.55	1.82	—	—	2.90	3.17	—	3.97	Road Runoff - Post-SC 11A&B
15	Combine	11, 13, 14	8.74	10.83	—	—	19.39	21.56	—	28.11	Comb SC 3,9,10,11
16	SCS Runoff	—	7.64	8.94	—	—	14.14	15.43	—	19.32	Paking RunOff - Post-SC 2
17	SCS Runoff	—	0.81	1.07	—	—	2.21	2.51	—	3.41	DI-1 - Post-SC 5
18	SCS Runoff	—	2.23	2.71	—	—	4.60	5.07	—	6.47	DI-12 - Post-SC 12
19	Combine	16, 17, 18	10.66	12.71	—	—	20.95	23.01	—	29.20	Comb SC 5 and SC 12
20	Reach	19	10.60	12.76	—	—	21.38	23.53	—	29.94	Reach from SC 5 and SC 12
21	Combine	15, 20	19.27	23.53	—	—	40.76	45.09	—	58.05	Combine
22	Reach	21	19.63	24.03	—	—	41.61	45.99	—	59.04	Reach
23	SCS Runoff	—	1.66	1.94	—	—	3.07	3.35	—	4.19	Pond - Post-SC 1
24	Combine	22, 23	20.86	25.47	—	—	43.88	48.46	—	62.14	Combine
25	Reservoir	24	2.91	5.39	—	—	11.86	12.28	—	27.95	Water Quality Pond
26	Reach	25	2.88	5.36	—	—	11.86	12.28	—	29.80	WQ Pond Outfall
27	SCS Runoff	—	0.93	1.26	—	—	2.73	3.12	—	4.29	Post-SC 13
28	SCS Runoff	—	1.42	1.83	—	—	3.54	3.97	—	5.28	Post-SC 14
29	Combine	27, 28	2.35	3.09	—	—	6.27	7.09	—	9.56	Burnt Poplar Drive Culvert
30	SCS Runoff	—	1.08	1.27	—	—	2.00	2.19	—	2.74	North Area - Post-SC 15

# Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
			1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
31	Combine	26, 29, 30	3.82	7.76	-----	-----	19.45	20.72	-----	39.83	All Post SCs
32	Combine	1, 2, 3, 4,	4.91	7.87	-----	-----	22.71	26.87	-----	39.99	All Pre SCs

# **10-Year Summary Report**

# Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	17.49	2	728	1.432	---	---	---	Pre-SC 1
2	SCS Runoff	2.89	2	722	0.191	---	---	---	Pre-SC 2
3	SCS Runoff	2.27	2	722	0.146	---	---	---	Pre-SC 3
4	SCS Runoff	0.64	2	722	0.042	---	---	---	Pre-SC 4
5	SCS Runoff	2.11	2	720	0.145	---	---	---	Roof East - Post-SC 10B
6	SCS Runoff	2.92	2	732	0.293	---	---	---	DI-6 - Post-SC 8
7	Combine	4.23	2	722	0.438	5, 6	---	---	Comb SC 8 and 10A
8	SCS Runoff	8.86	2	720	0.535	---	---	---	DI-3,4, 5 - Post-SC 7a,7b, 7c
9	SCS Runoff	1.64	2	716	0.076	---	---	---	DI-2 - Post-SC 4
10	SCS Runoff	0.94	2	718	0.050	---	---	---	DI-7, 8 - Post-SC 6
11	Combine	15.14	2	720	1.099	7, 8, 9, 10	---	---	Comb SC 4, 6, 7, 8, 10
12	SCS Runoff	3.87	2	720	0.234	---	---	---	DI-9,10A,11 - Post-SC 9
13	SCS Runoff	2.11	2	720	0.145	---	---	---	Roof West - Post-SC 10A
14	SCS Runoff	2.90	2	716	0.157	---	---	---	Road Runoff - Post-SC 11A&B
15	Combine	19.39	2	720	1.401	11, 13, 14	---	---	Comb SC 3,9,10,11
16	SCS Runoff	14.14	2	716	0.777	---	---	---	Paking RunOff - Post-SC 2
17	SCS Runoff	2.21	2	716	0.103	---	---	---	DI-1 - Post-SC 5
18	SCS Runoff	4.60	2	716	0.230	---	---	---	DI-12 - Post-SC 12
19	Combine	20.95	2	716	1.111	16, 17, 18	---	---	Comb SC 5 and SC 12
20	Reach	21.38	2	718	1.111	19	---	---	Reach from SC 5 and SC 12
21	Combine	40.76	2	718	2.512	15, 20	---	---	Combine
22	Reach	41.61	2	720	2.511	21	---	---	Reach
23	SCS Runoff	3.07	2	716	0.169	---	---	---	Pond - Post-SC 1
24	Combine	43.88	2	720	2.680	22, 23	---	---	Combine
25	Reservoir	11.86	2	732	2.475	24	905.58	1.802	Water Quality Pond
26	Reach	11.86	2	734	2.473	25	---	---	WQ Pond Outfall
27	SCS Runoff	2.73	2	722	0.176	---	---	---	Post-SC 13
28	SCS Runoff	3.54	2	722	0.230	---	---	---	Post-SC 14
29	Combine	6.27	2	722	0.406	27, 28	---	---	Burnt Poplar Drive Culvert
30	SCS Runoff	2.00	2	730	0.206	---	---	---	North Area - Post-SC 15

# Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
31	Combine	19.45	2	724	3.085	26, 29, 30	-----	-----	All Post SCs
32	Combine	22.71	2	726	1.811	1, 2, 3, 4,	-----	-----	All Pre SCs

# **10-Year Hydrograph Reports**

# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

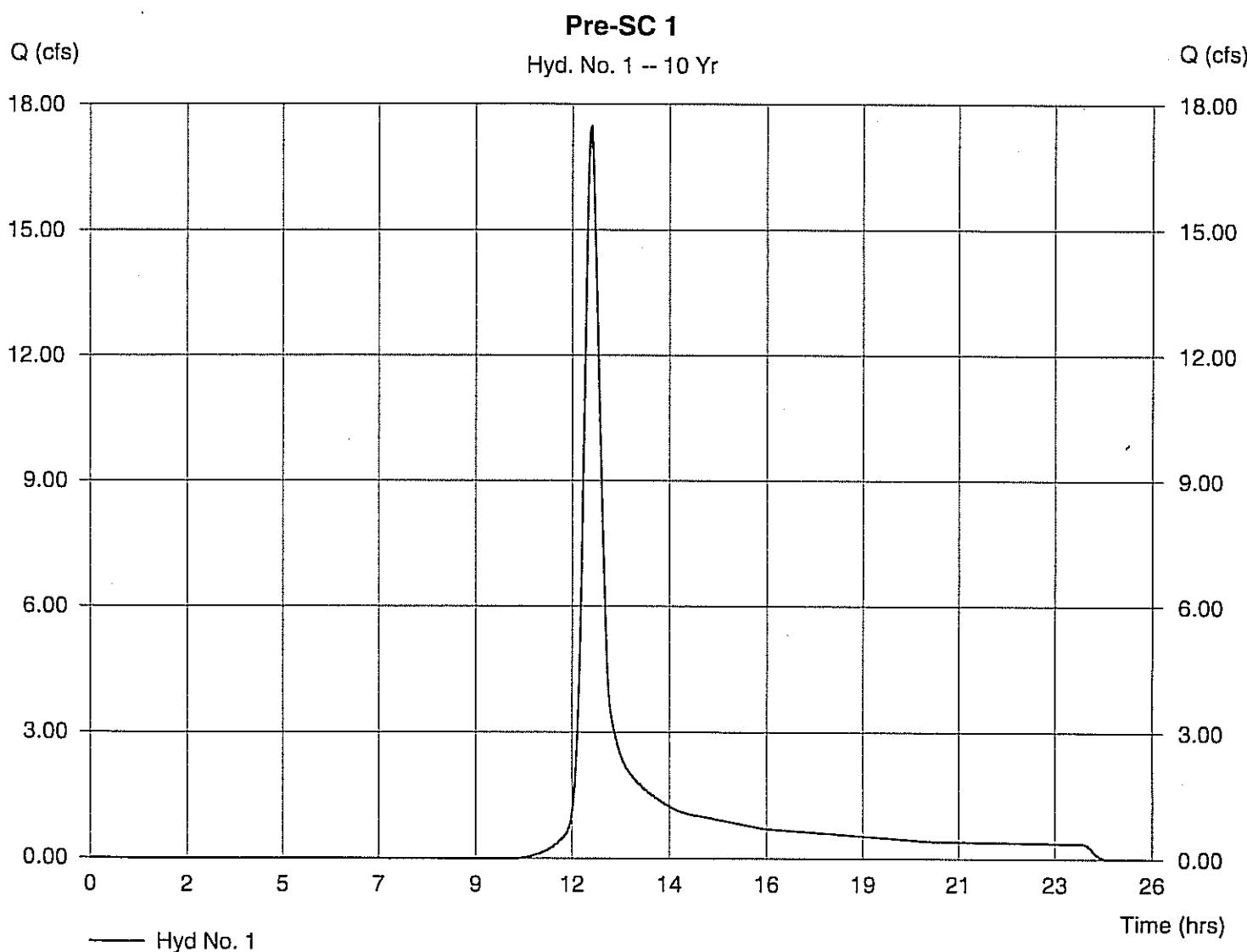
## Hyd. No. 1

Pre-SC 1

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 8.13 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 17.49 cfs  
Time interval = 2 min  
Curve number = 66  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 23 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 1.432 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

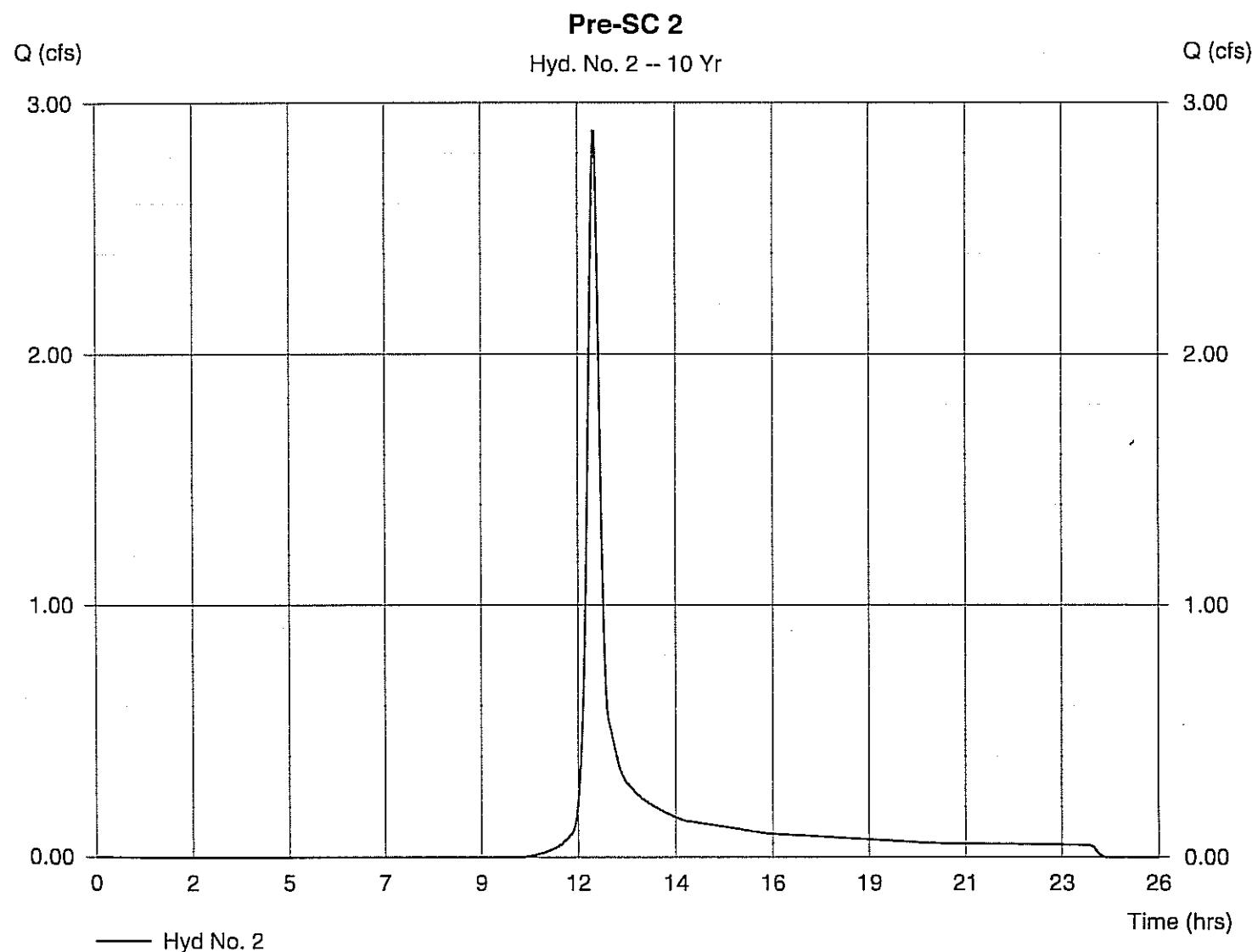
## Hyd. No. 2

### Pre-SC 2

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 1.13 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.89 cfs  
Time interval = 2 min  
Curve number = 66  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 16 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.191 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

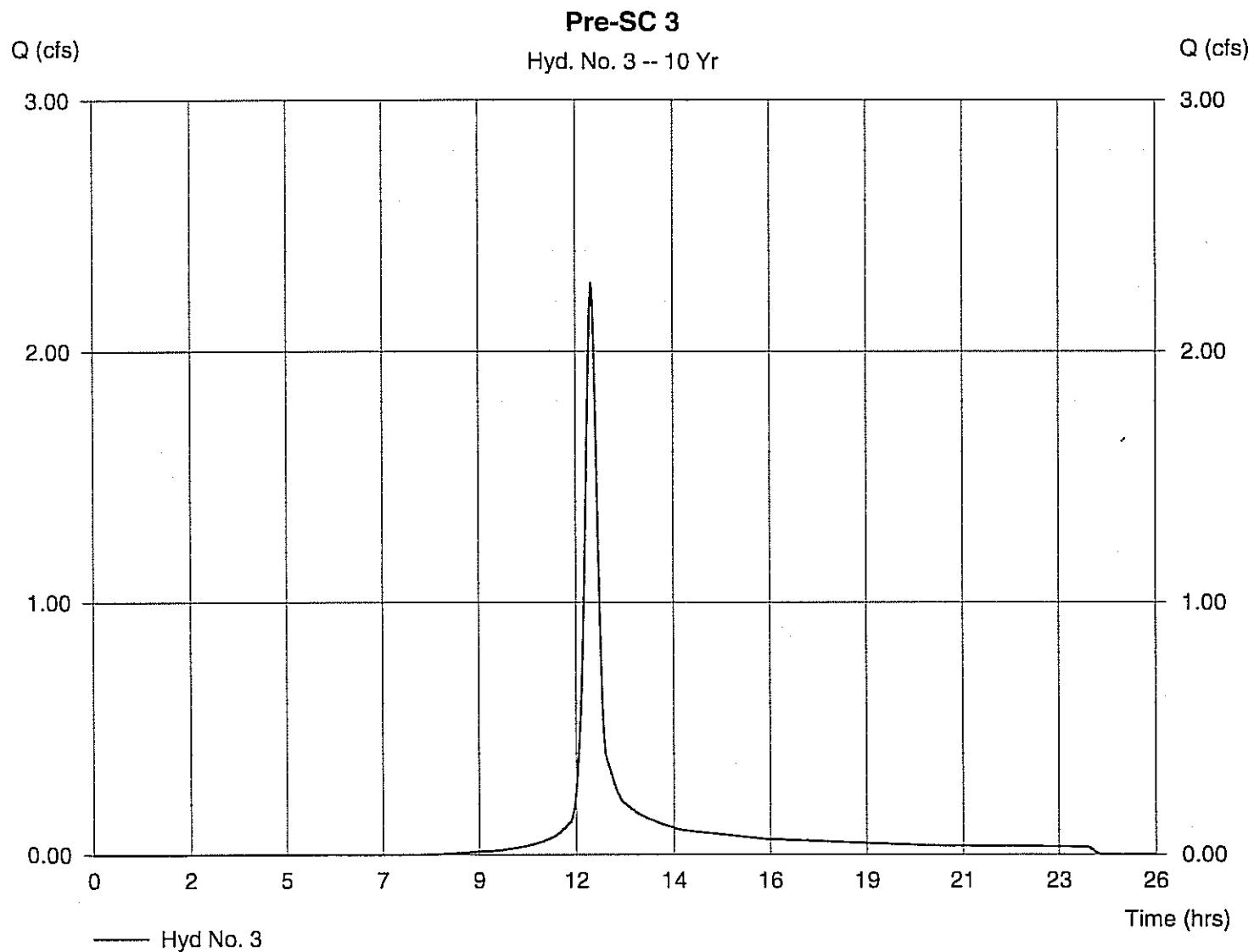
## Hyd. No. 3

Pre-SC 3

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.61 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.27 cfs  
Time interval = 2 min  
Curve number = 76  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 13.9 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.146 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

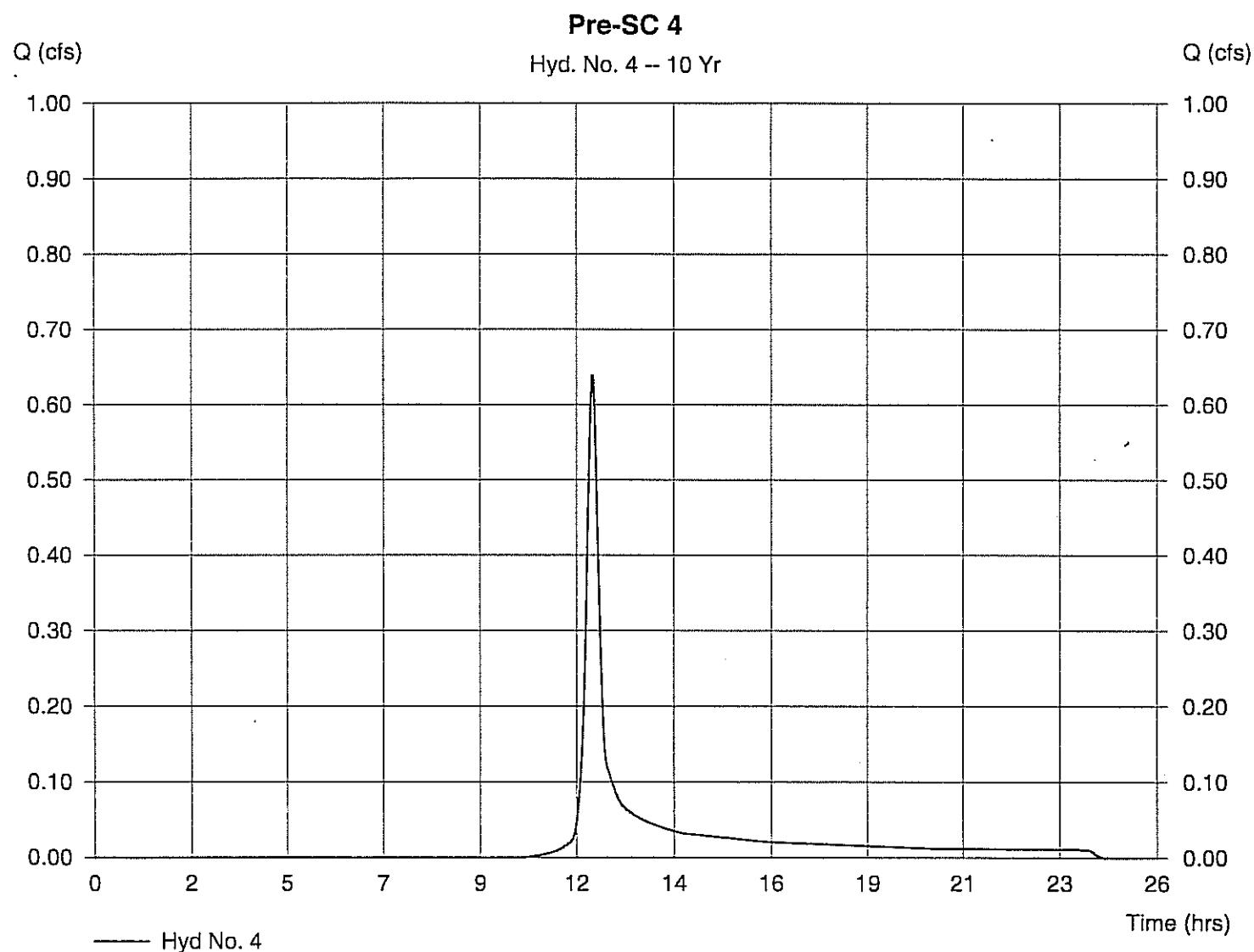
## Hyd. No. 4

Pre-SC 4

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.25 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 0.64 cfs  
Time interval = 2 min  
Curve number = 66  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 13.9 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.042 acft



# Hydrograph Plot

Hydralow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 5

Roof East - Post-SC 10B

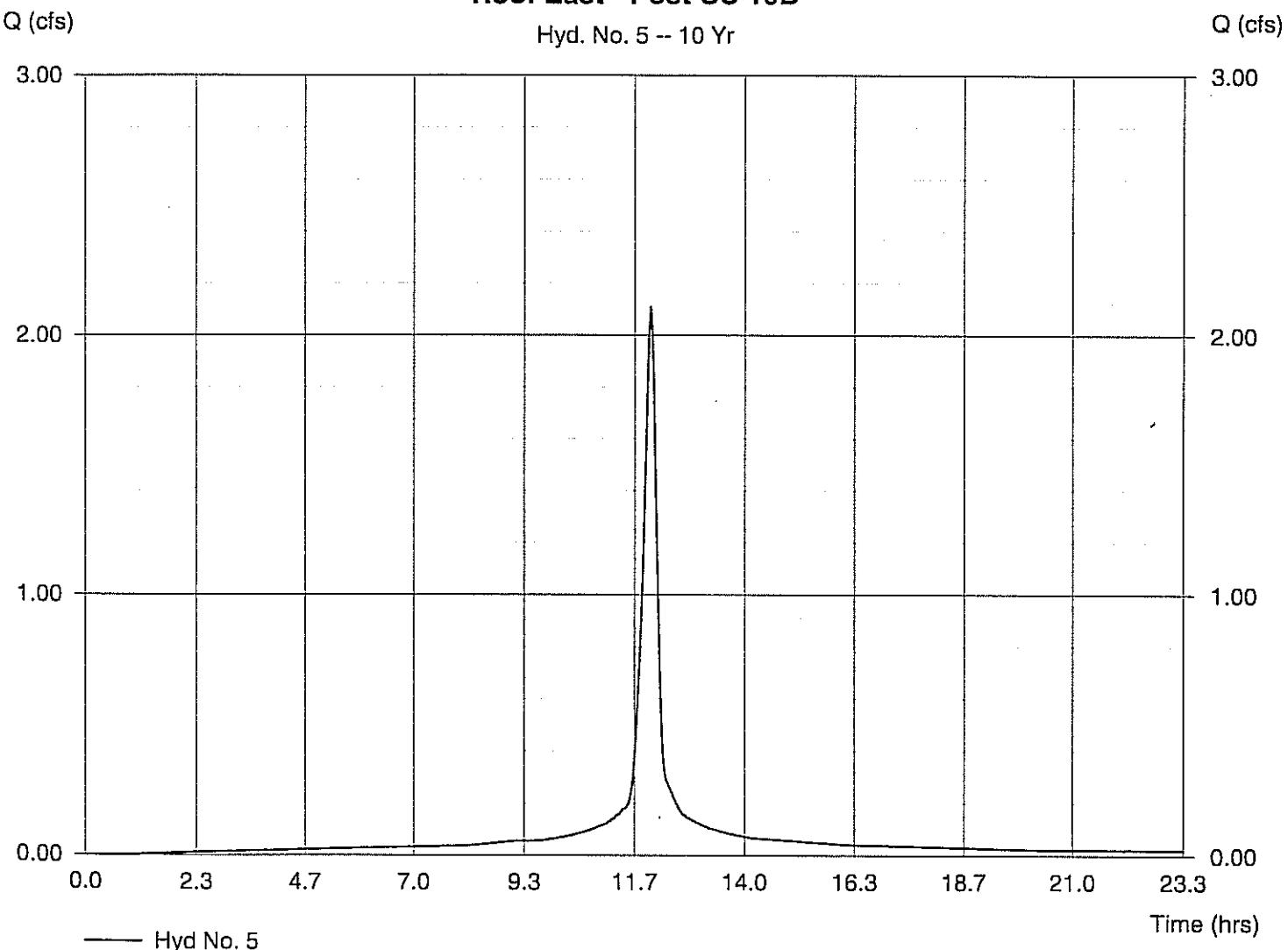
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.32 ac  
Basin Slope = 4.0 %  
Tc method = USER  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.11 cfs  
Time interval = 2 min  
Curve number = 98  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 10 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.145 acft

Roof East - Post-SC 10B

Hyd. No. 5 -- 10 Yr



— Hyd No. 5

# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

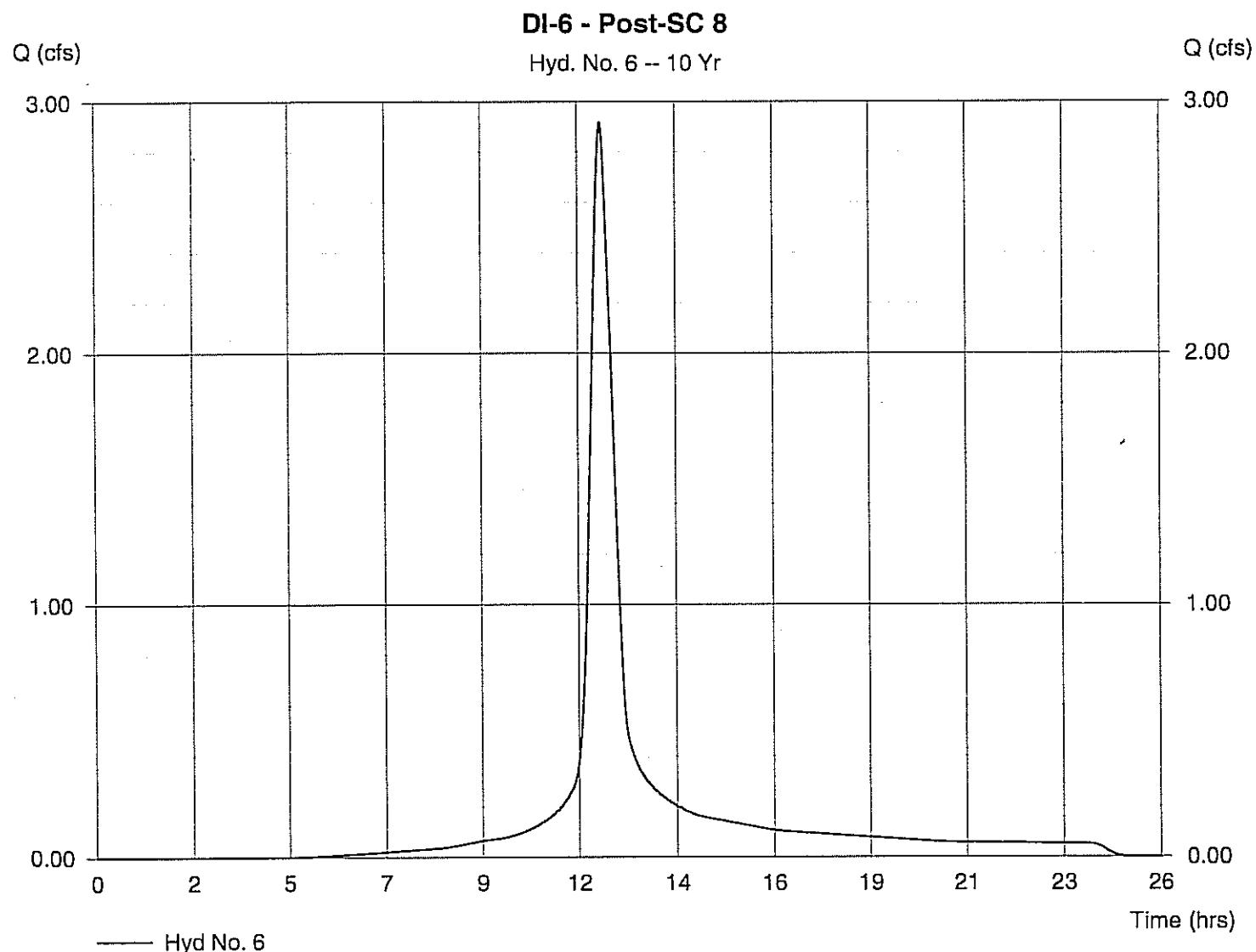
## Hyd. No. 6

DI-6 - Post-SC 8

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.86 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.92 cfs  
Time interval = 2 min  
Curve number = 87  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 30.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.293 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 7

Comb SC 8 and 10A

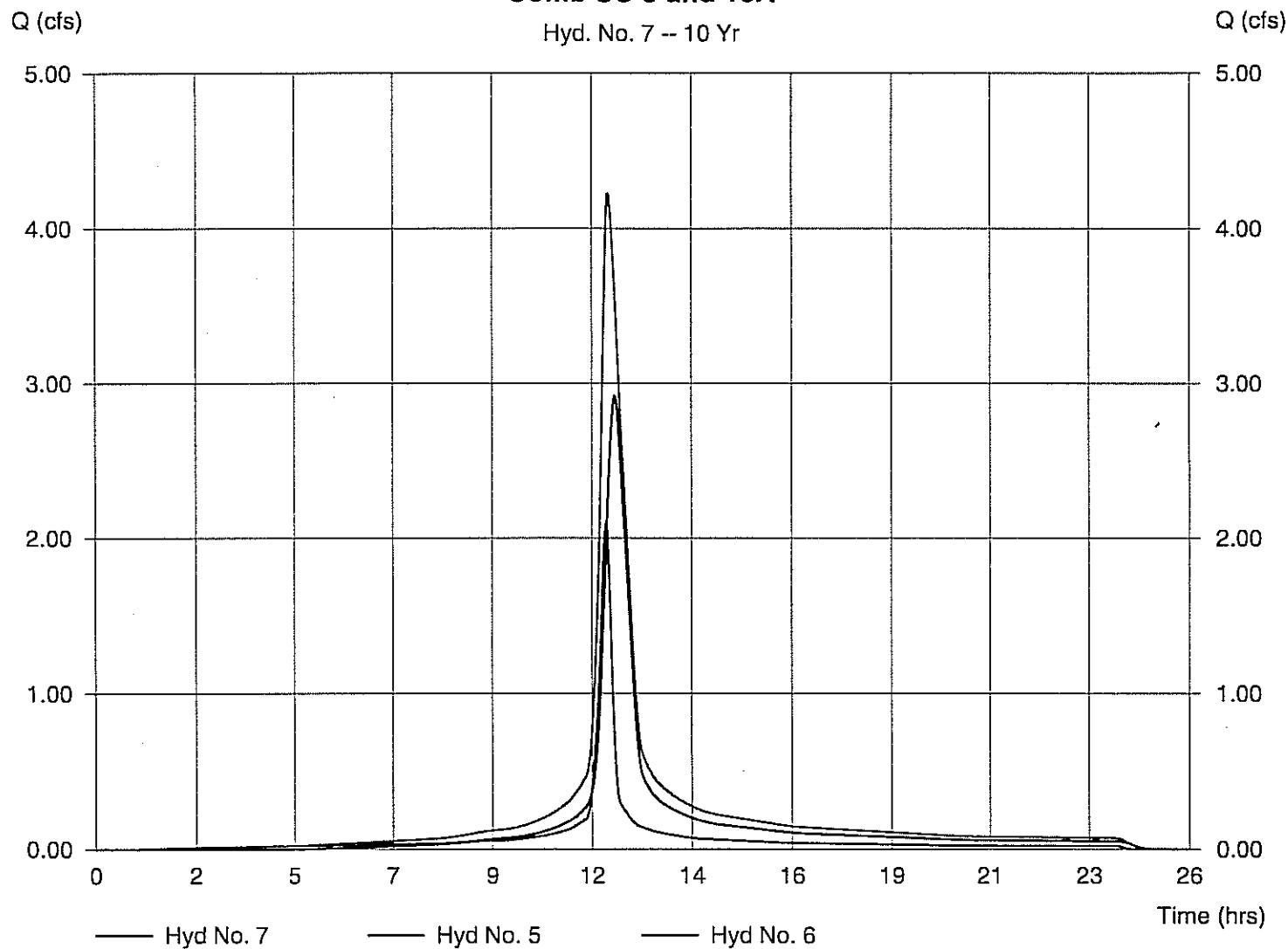
Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 5, 6

Peak discharge = 4.23 cfs  
Time interval = 2 min

Hydrograph Volume = 0.438 acft

### Comb SC 8 and 10A

Hyd. No. 7 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 8

DI-3,4, 5 - Post-SC 7a,7b, 7c

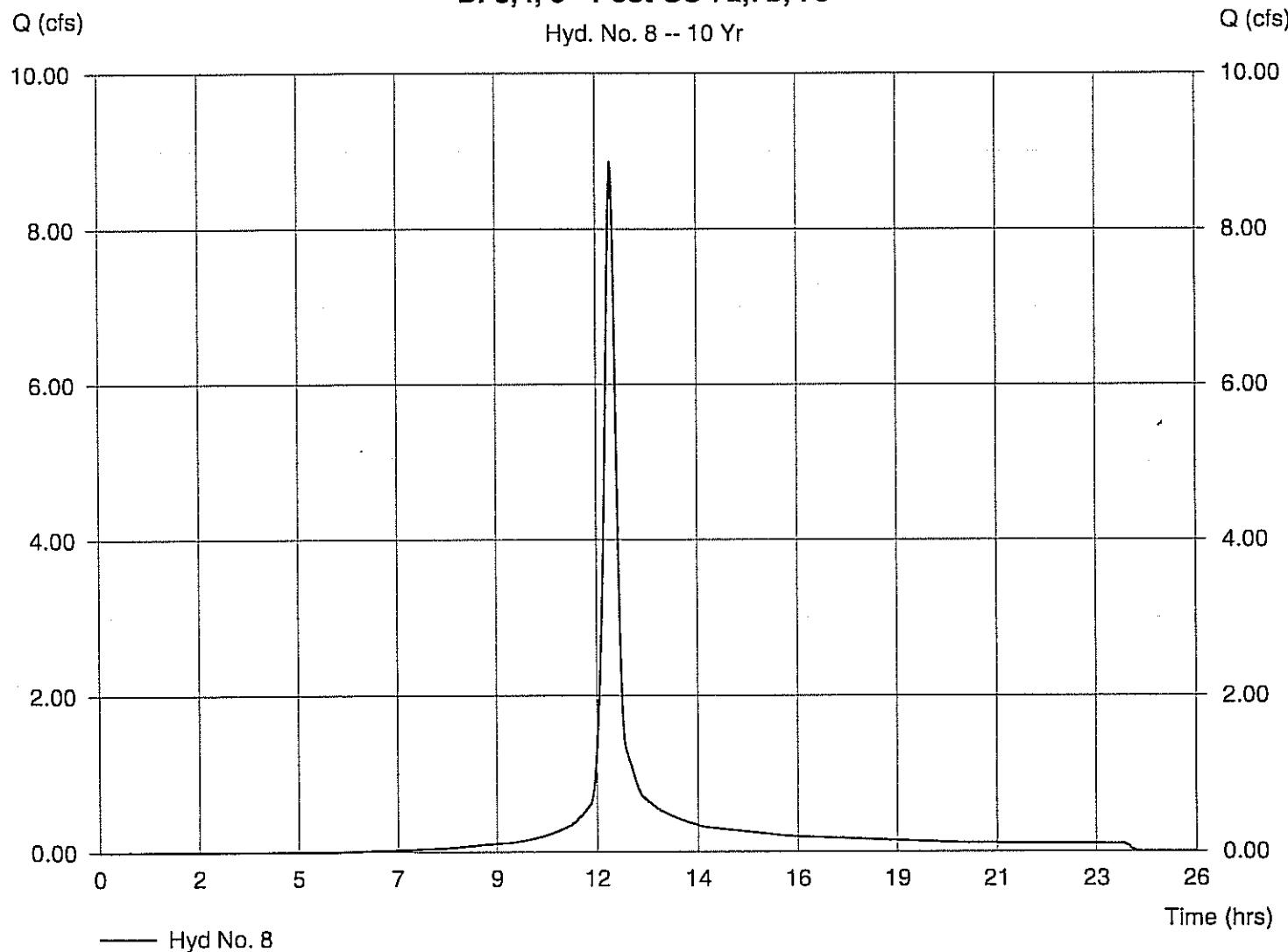
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 1.67 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 8.86 cfs  
Time interval = 2 min  
Curve number = 84  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 12.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.535 acft

DI-3,4, 5 - Post-SC 7a,7b, 7c

Hyd. No. 8 -- 10 Yr



# Hydrograph Plot

Hydraflo Hydrographs by Intellisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 9

DI-2 - Post-SC 4

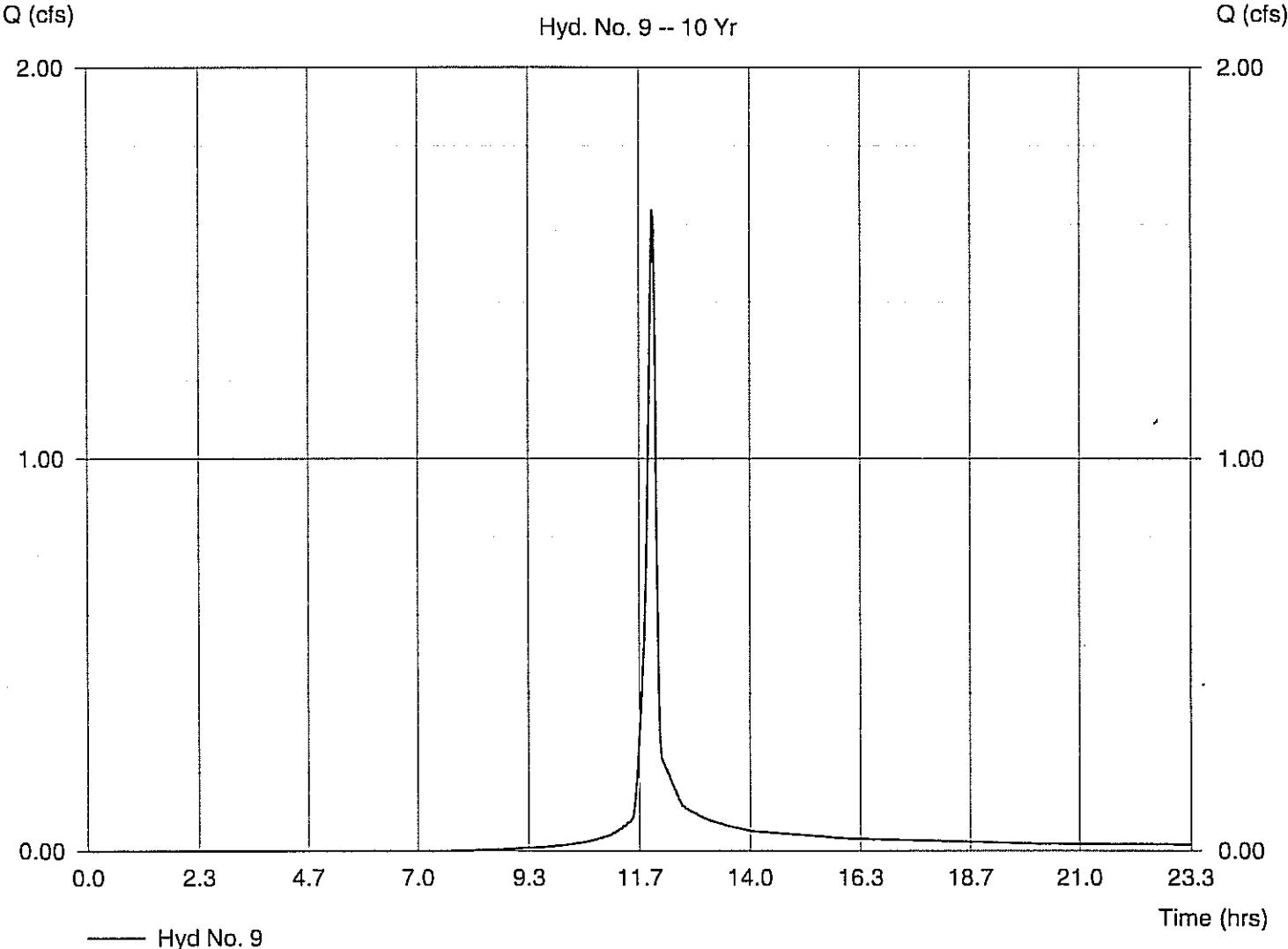
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.32 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 1.64 cfs  
Time interval = 2 min  
Curve number = 77  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 5.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.076 acft

DI-2 - Post-SC 4

Hyd. No. 9 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 10

DI-7, 8 - Post-SC 6

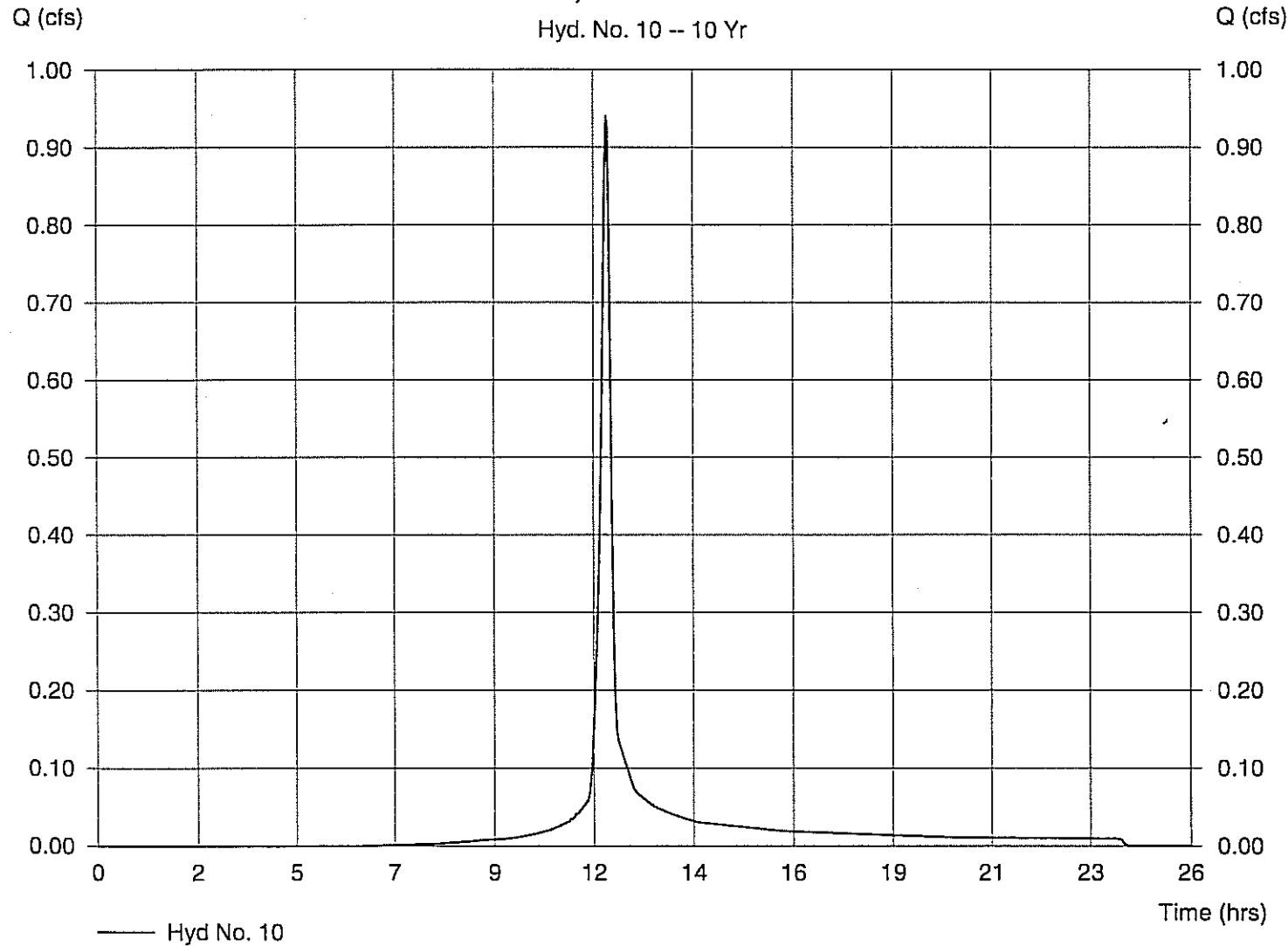
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.17 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 0.94 cfs  
Time interval = 2 min  
Curve number = 82  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 9.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.050 acft

### DI-7, 8 - Post-SC 6

Hyd. No. 10 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 11

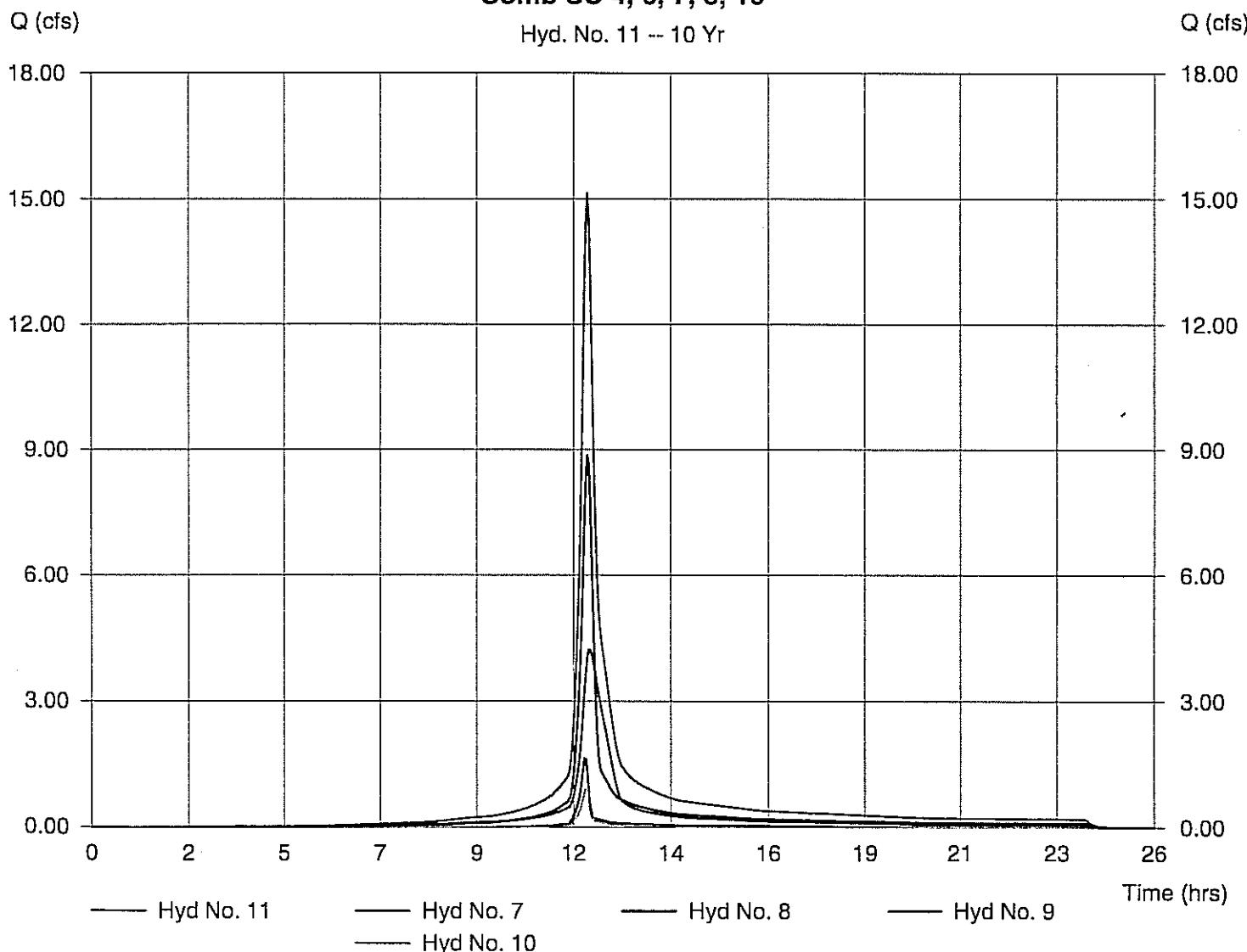
Comb SC 4, 6, 7, 8, 10

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 7, 8, 9, 10

Peak discharge = 15.14 cfs  
Time interval = 2 min

Hydrograph Volume = 1.099 acft

Comb SC 4, 6, 7, 8, 10  
Hyd. No. 11 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 12

DI-9,10A,11 - Post-SC 9

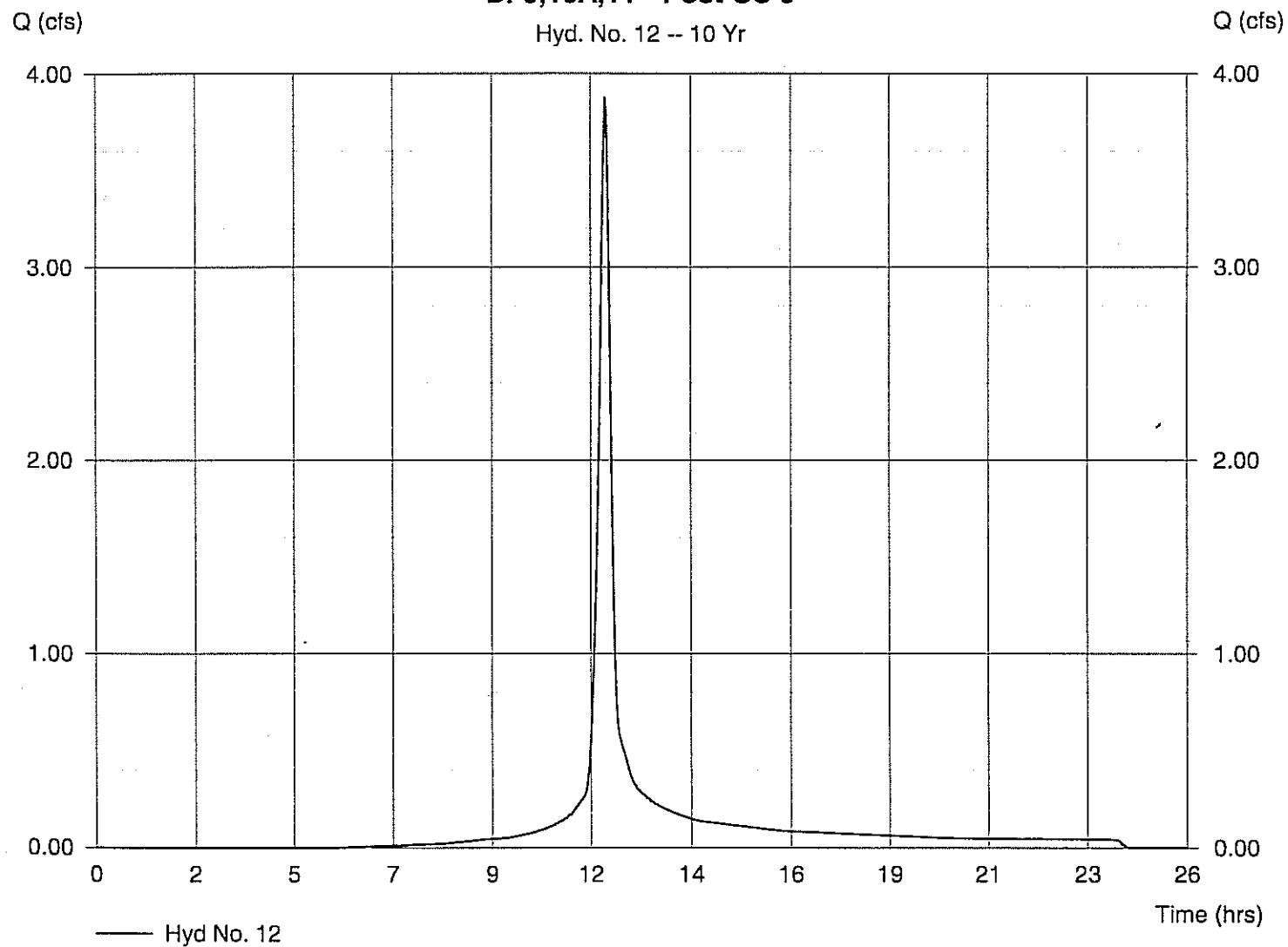
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.73 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 3.87 cfs  
Time interval = 2 min  
Curve number = 84  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 10.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.234 acft

DI-9,10A,11 - Post-SC 9

Hyd. No. 12 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intellisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 13

Roof West - Post-SC 10A

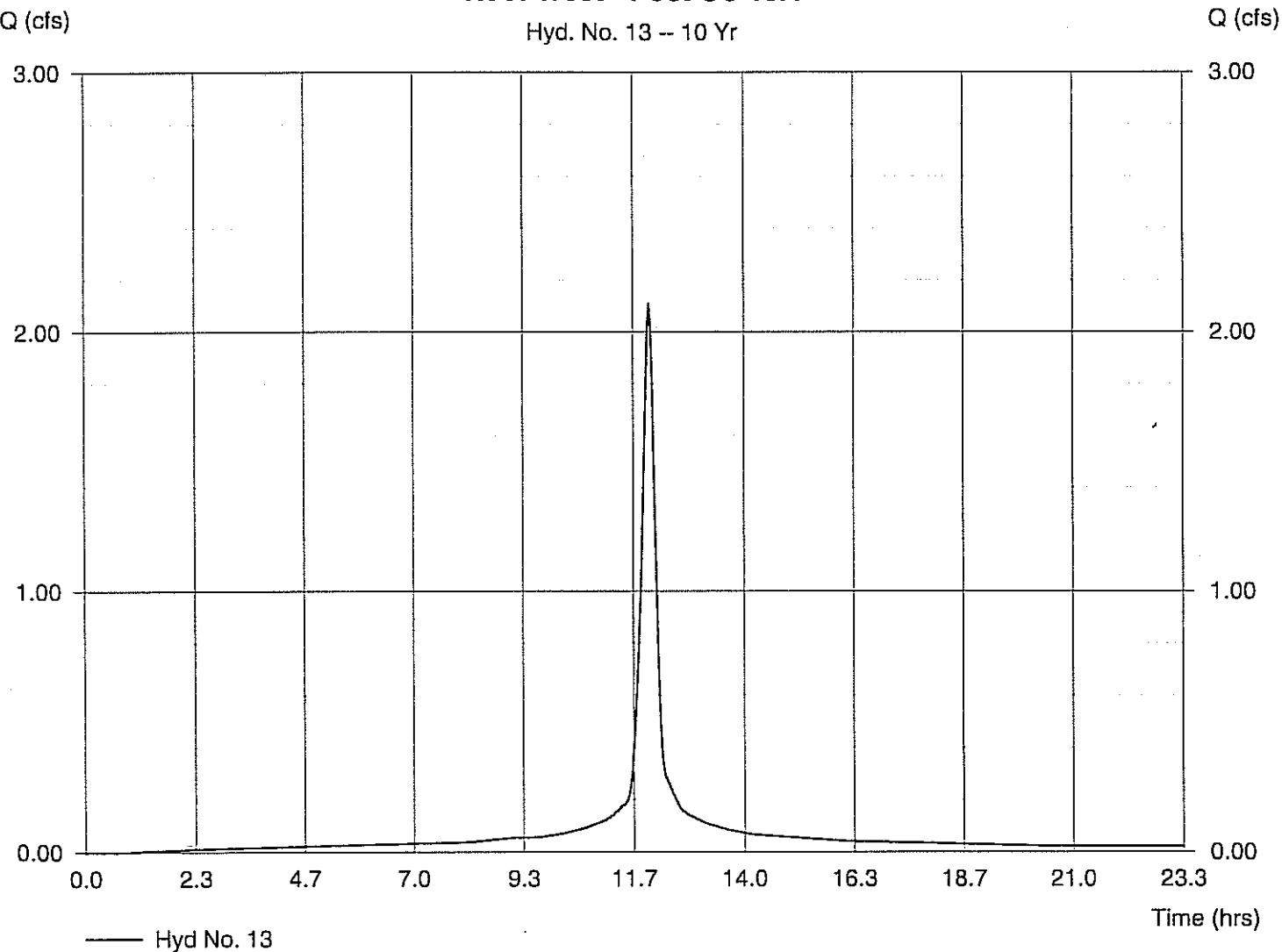
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.32 ac  
Basin Slope = 4.0 %  
Tc method = USER  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.11 cfs  
Time interval = 2 min  
Curve number = 98  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 10 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.145 acft

Roof West - Post-SC 10A

Hyd. No. 13 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 14

Road Runoff - Post-SC 11A&B

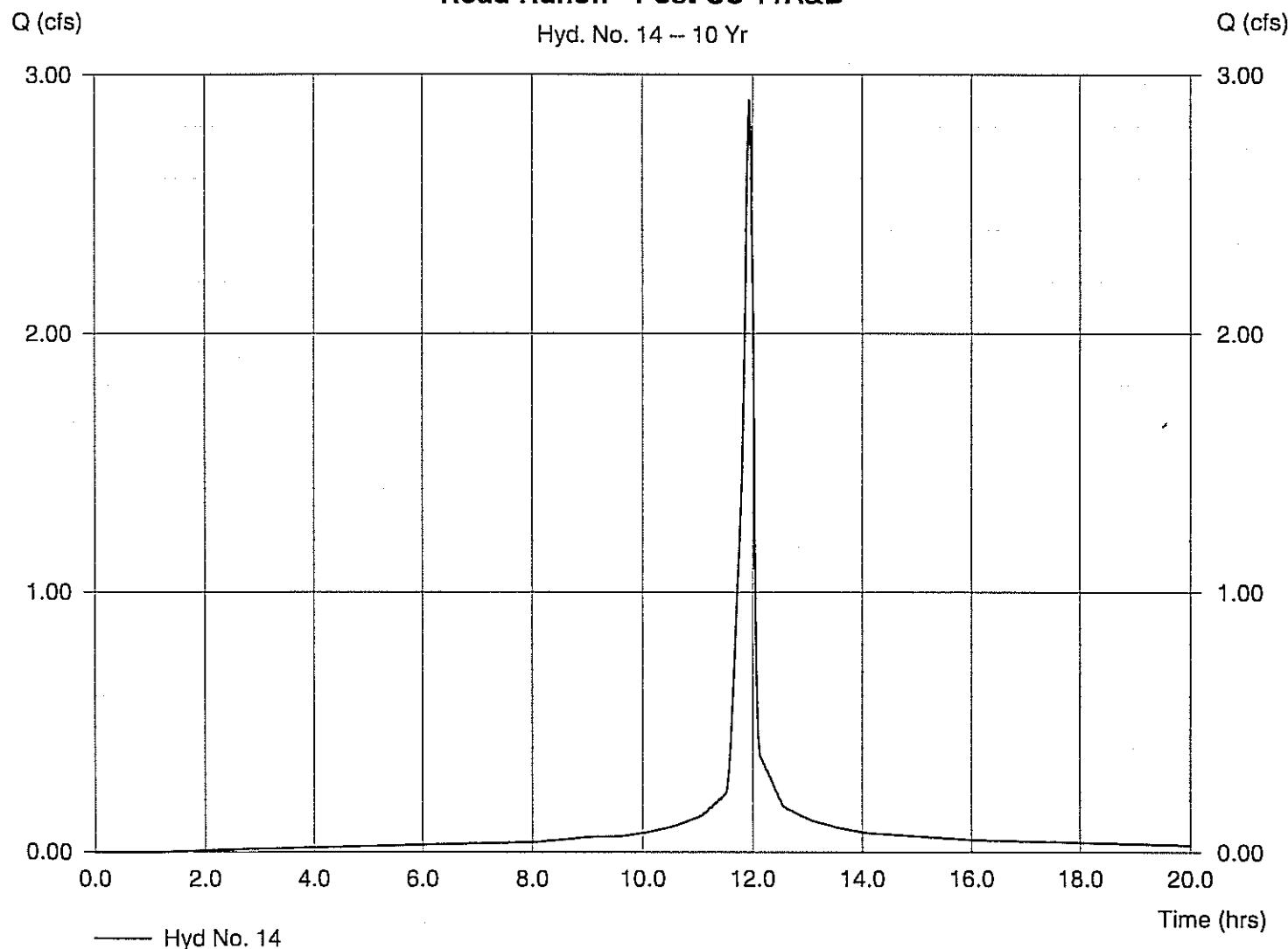
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.39 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.90 cfs  
Time interval = 2 min  
Curve number = 97  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 5.3 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.157 acft

### Road Runoff - Post-SC 11A&B

Hyd. No. 14 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 15

Comb SC 3,9,10,11

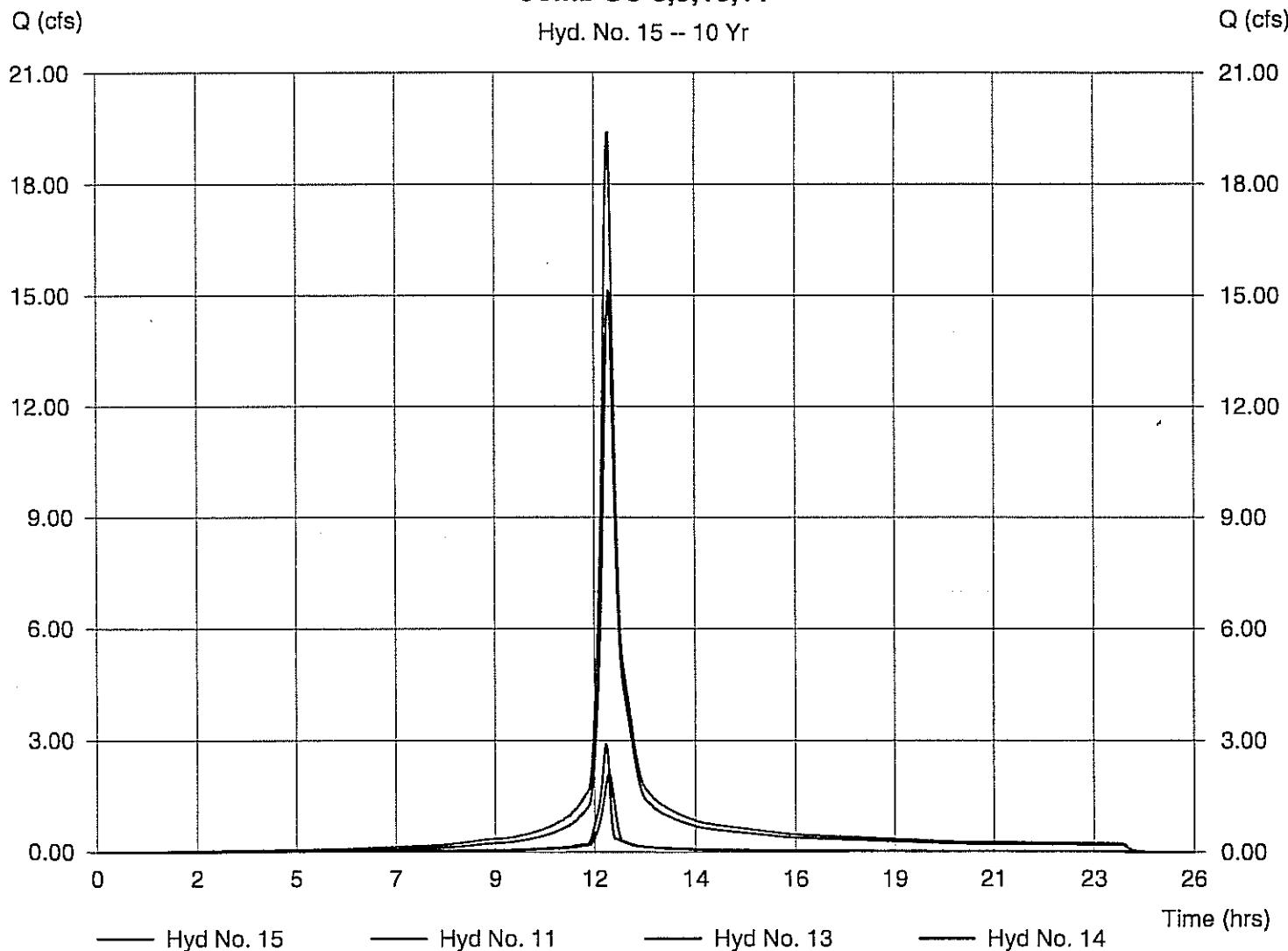
Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 11, 13, 14

Peak discharge = 19.39 cfs  
Time interval = 2 min

Hydrograph Volume = 1.401 acft

### Comb SC 3,9,10,11

Hyd. No. 15 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 16

Paking RunOff - Post-SC 2

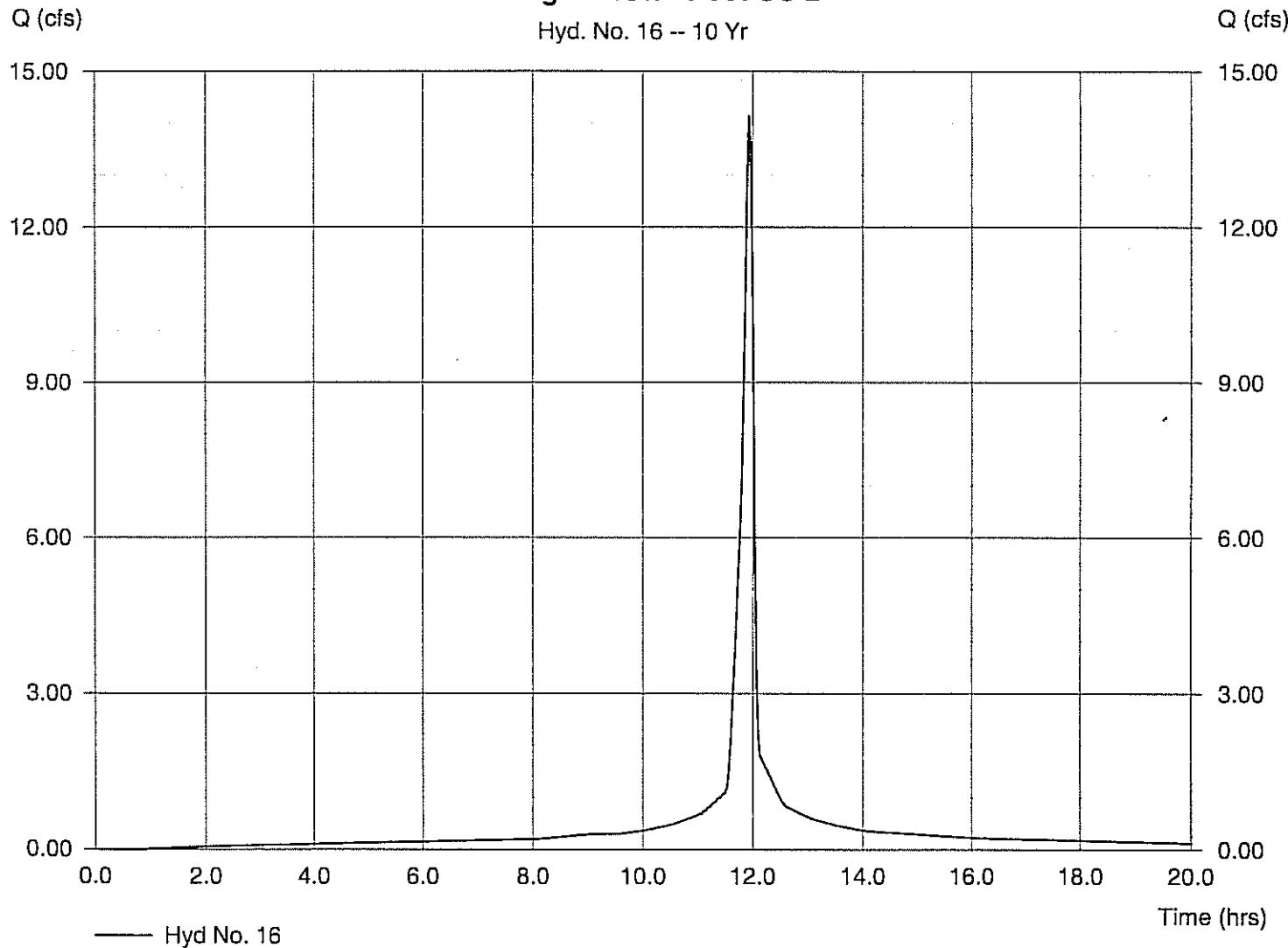
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 1.89 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 14.14 cfs  
Time interval = 2 min  
Curve number = 98  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 3.1 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.777 acft

### Paking RunOff - Post-SC 2

Hyd. No. 16 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

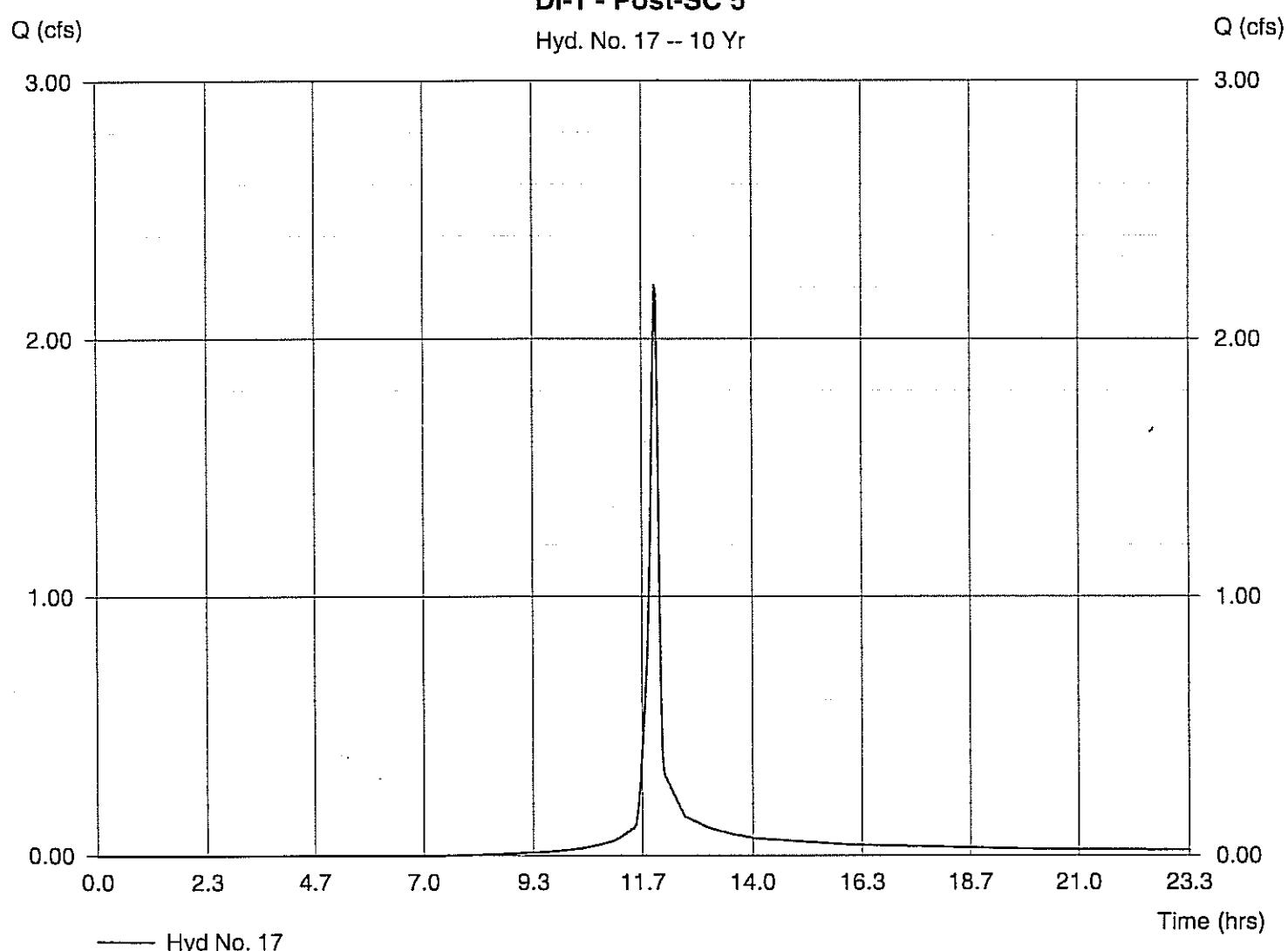
## Hyd. No. 17

DI-1 - Post-SC 5

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.42 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.21 cfs  
Time interval = 2 min  
Curve number = 78  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.103 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

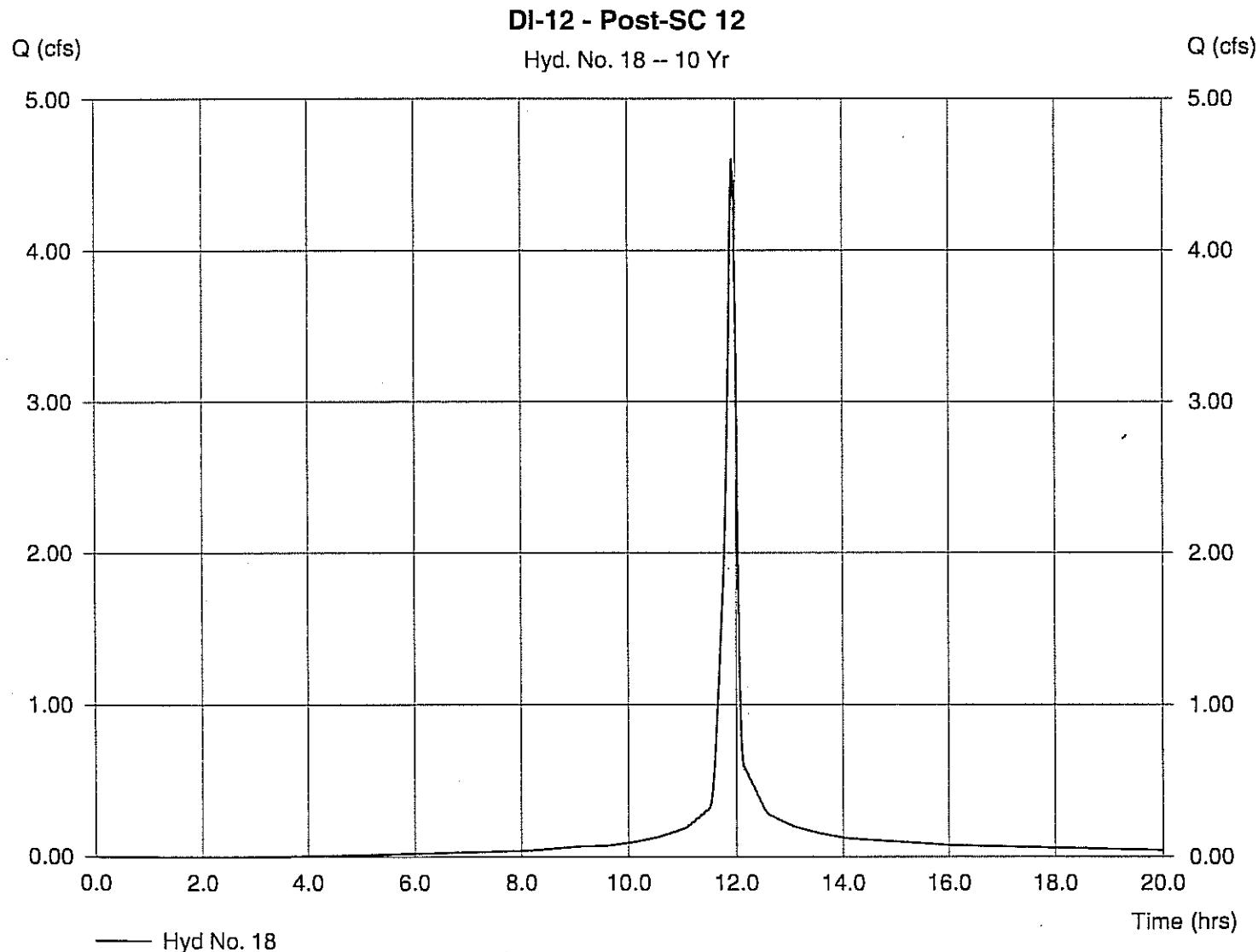
## Hyd. No. 18

DI-12 - Post-SC 12

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.66 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 4.60 cfs  
Time interval = 2 min  
Curve number = 91  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 3.6 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.230 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 19

Comb SC 5 and SC 12

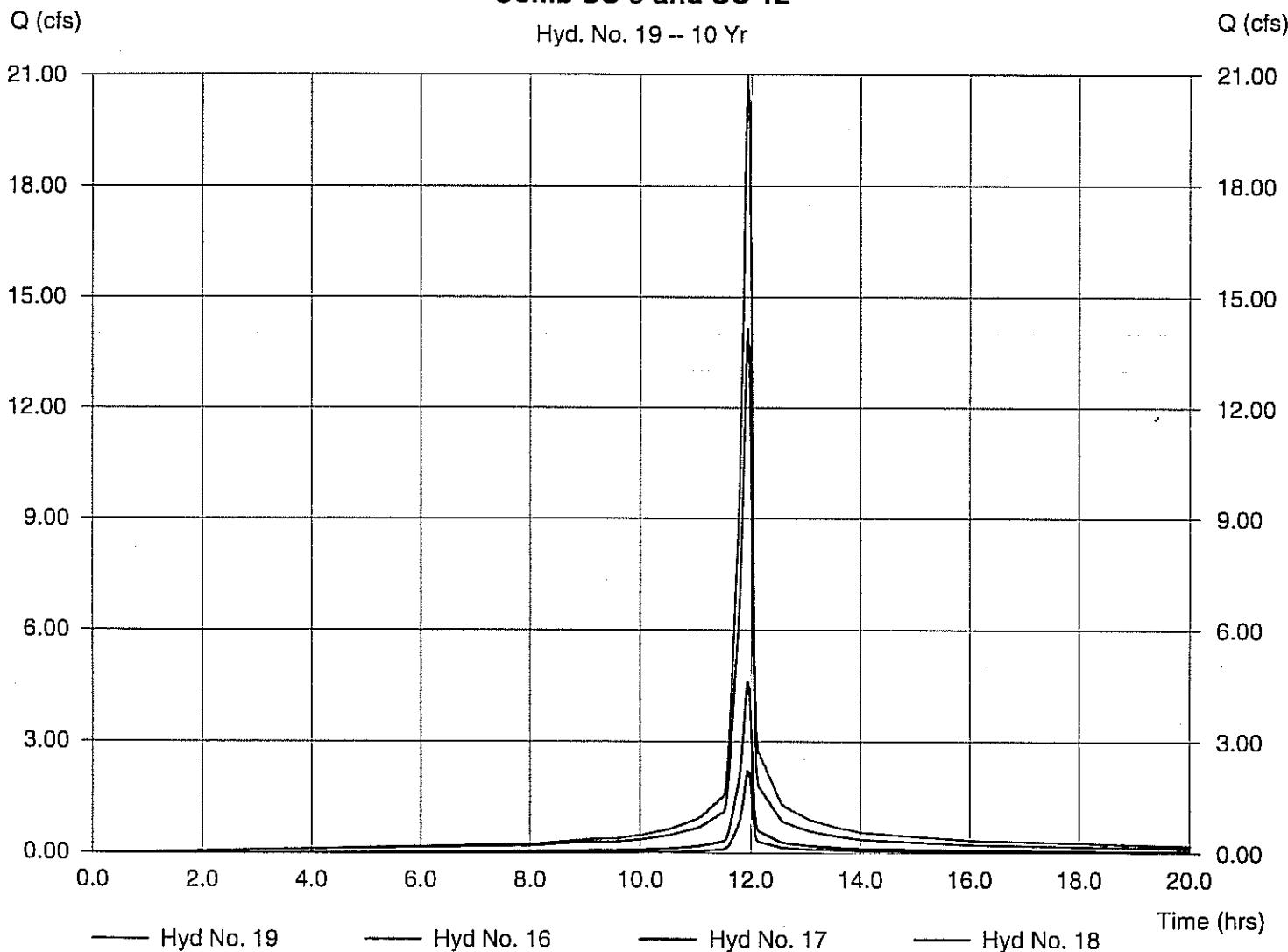
Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 16, 17, 18

Peak discharge = 20.95 cfs  
Time interval = 2 min

Hydrograph Volume = 1.111 acft

### Comb SC 5 and SC 12

Hyd. No. 19 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intellsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 20

Reach from SC 5 and SC 12

Hydrograph type = Reach  
Storm frequency = 10 yrs  
Inflow hyd. No. = 19  
Reach length = 500.0 ft  
Manning's n = 0.009  
Side slope = 0.0:1  
Rating curve x = 3.023  
Ave. velocity = 11.85 ft/s

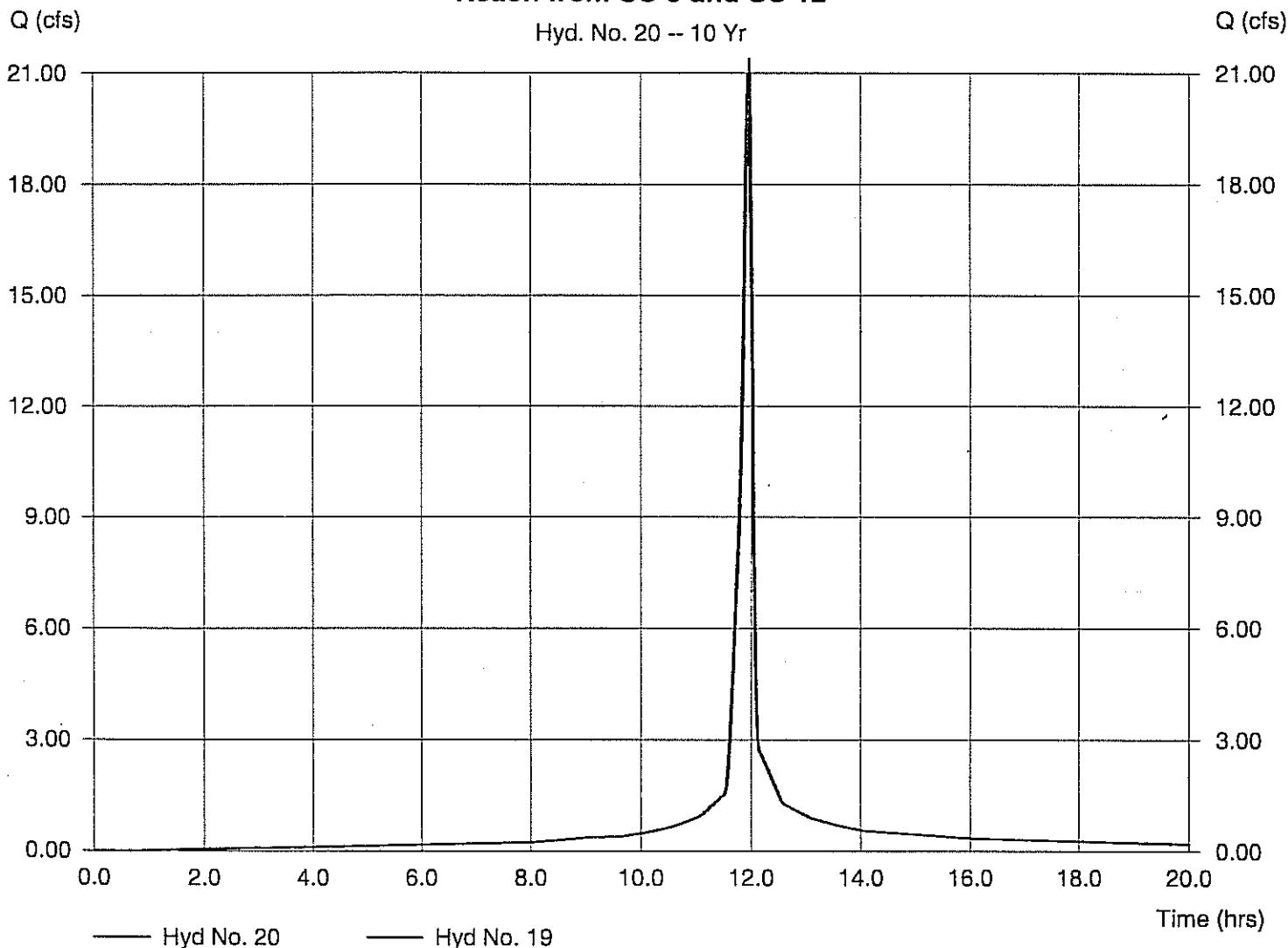
Peak discharge = 21.38 cfs  
Time interval = 2 min  
Section type = Circular  
Channel slope = 0.1 %  
Bottom width = 1.5 ft  
Max. depth = 0.0 ft  
Rating curve m = 1.250  
Routing coeff. = 1.2801

Modified Alt-Kin routing method used.

Hydrograph Volume = 1.111 acft

### Reach from SC 5 and SC 12

Hyd. No. 20 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 21

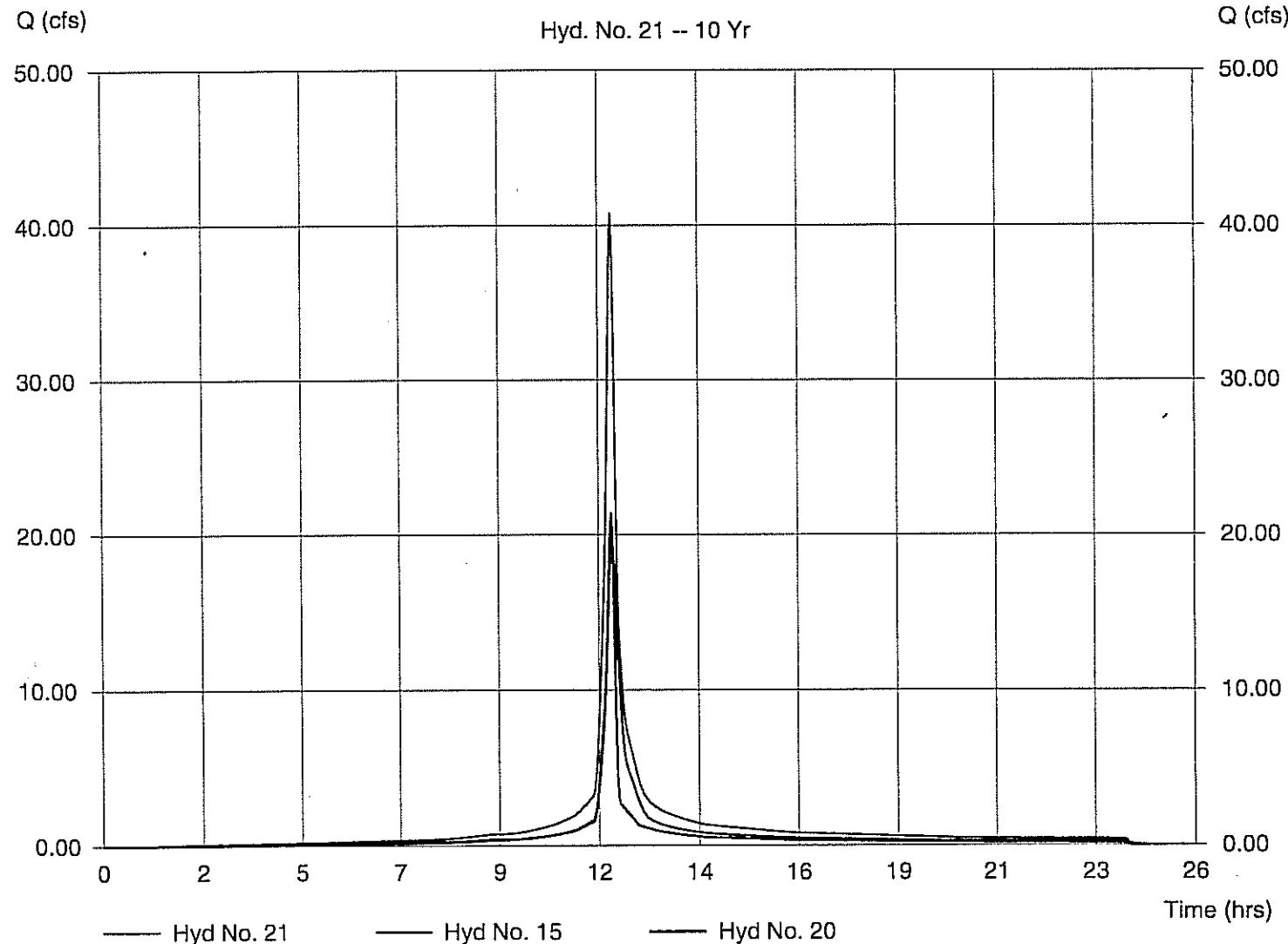
Combine

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 15, 20

Peak discharge = 40.76 cfs  
Time interval = 2 min

Hydrograph Volume = 2.512 acft

Combine  
Hyd. No. 21 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 22

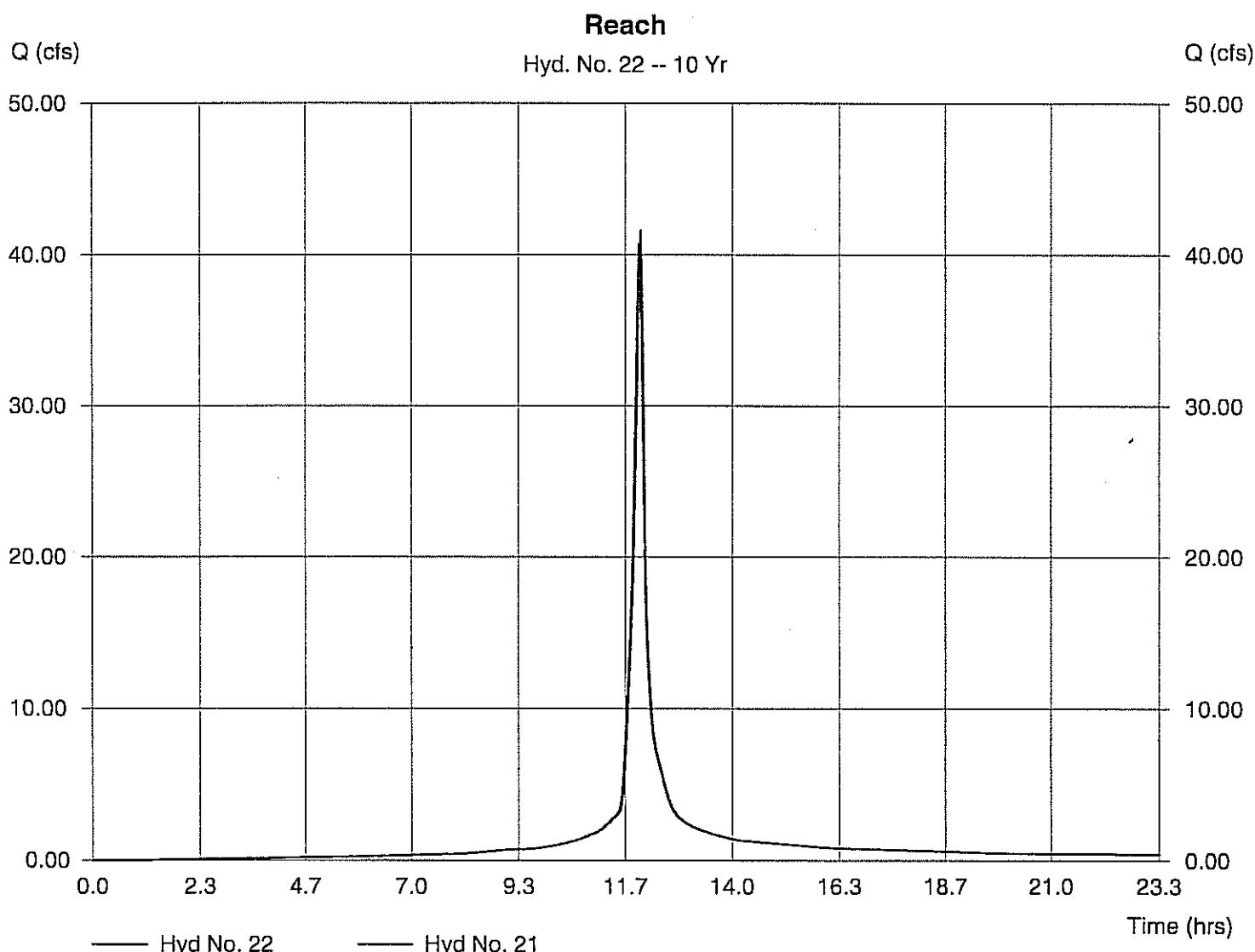
### Reach

Hydrograph type = Reach  
Storm frequency = 10 yrs  
Inflow hyd. No. = 21  
Reach length = 500.0 ft  
Manning's n = 0.009  
Side slope = 0.0:1  
Rating curve x = 3.023  
Ave. velocity = 23.07 ft/s

Peak discharge = 41.61 cfs  
Time interval = 2 min  
Section type = Circular  
Channel slope = 0.1 %  
Bottom width = 1.5 ft  
Max. depth = 0.0 ft  
Rating curve m = 1.250  
Routing coeff. = 1.5516

Modified Att-Kin routing method used.

Hydrograph Volume = 2.511 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 23

Pond - Post-SC 1

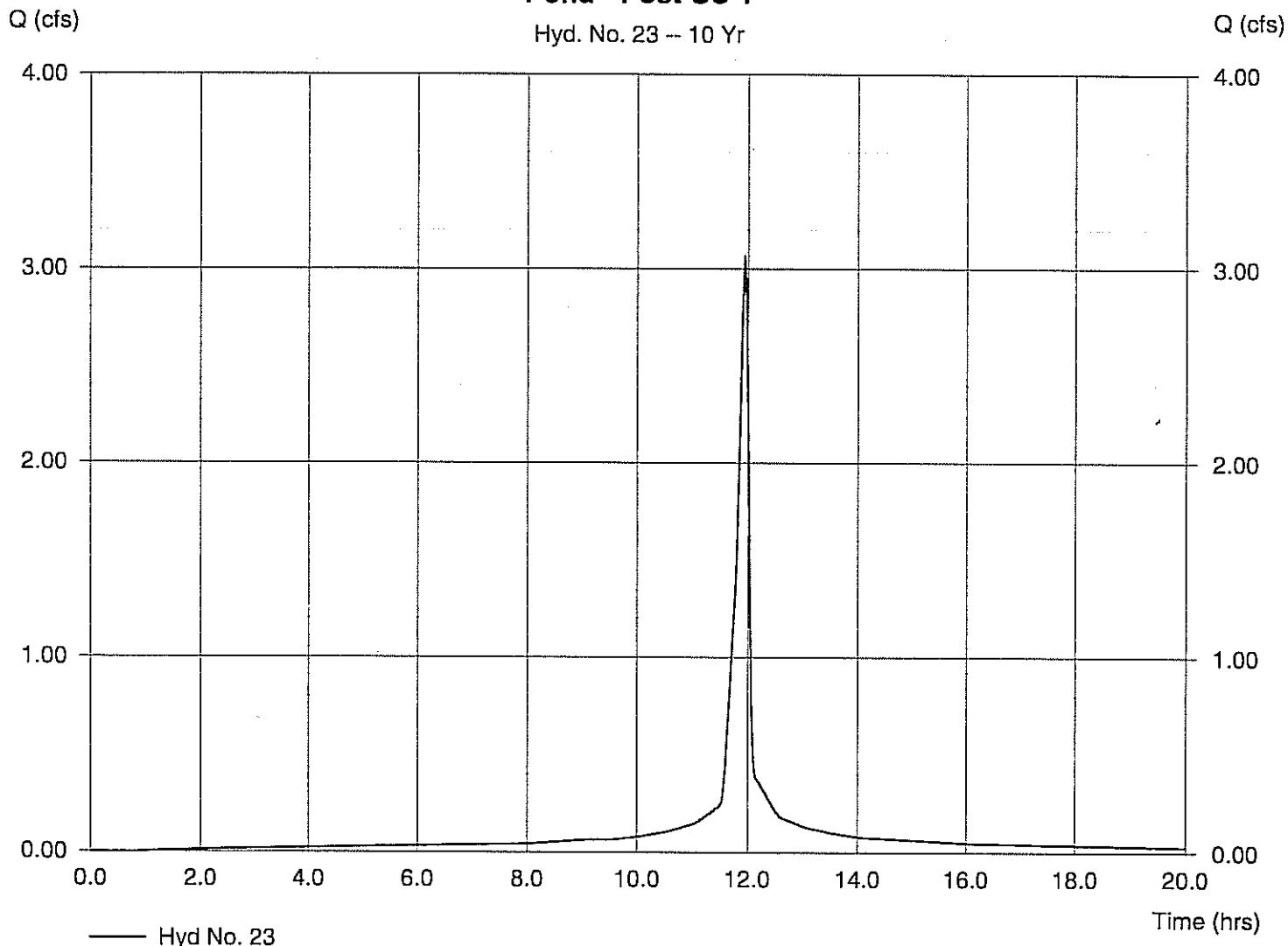
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.41 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 3.07 cfs  
Time interval = 2 min  
Curve number = 98  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 3.8 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.169 acft

### Pond - Post-SC 1

Hyd. No. 23 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 24

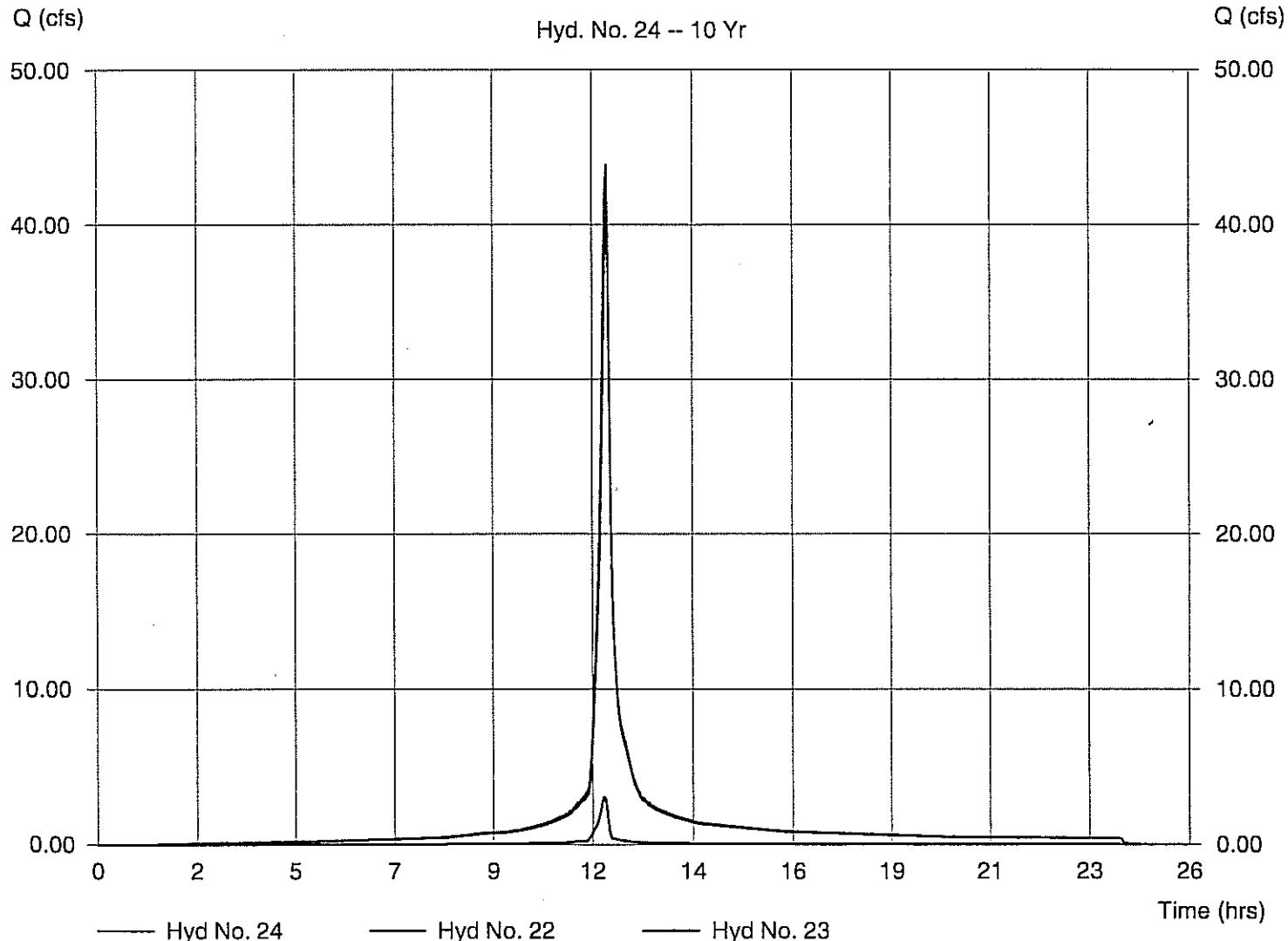
Combine

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 22, 23

Peak discharge = 43.88 cfs  
Time interval = 2 min

Hydrograph Volume = 2.680 acft

Combine  
Hyd. No. 24 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 25

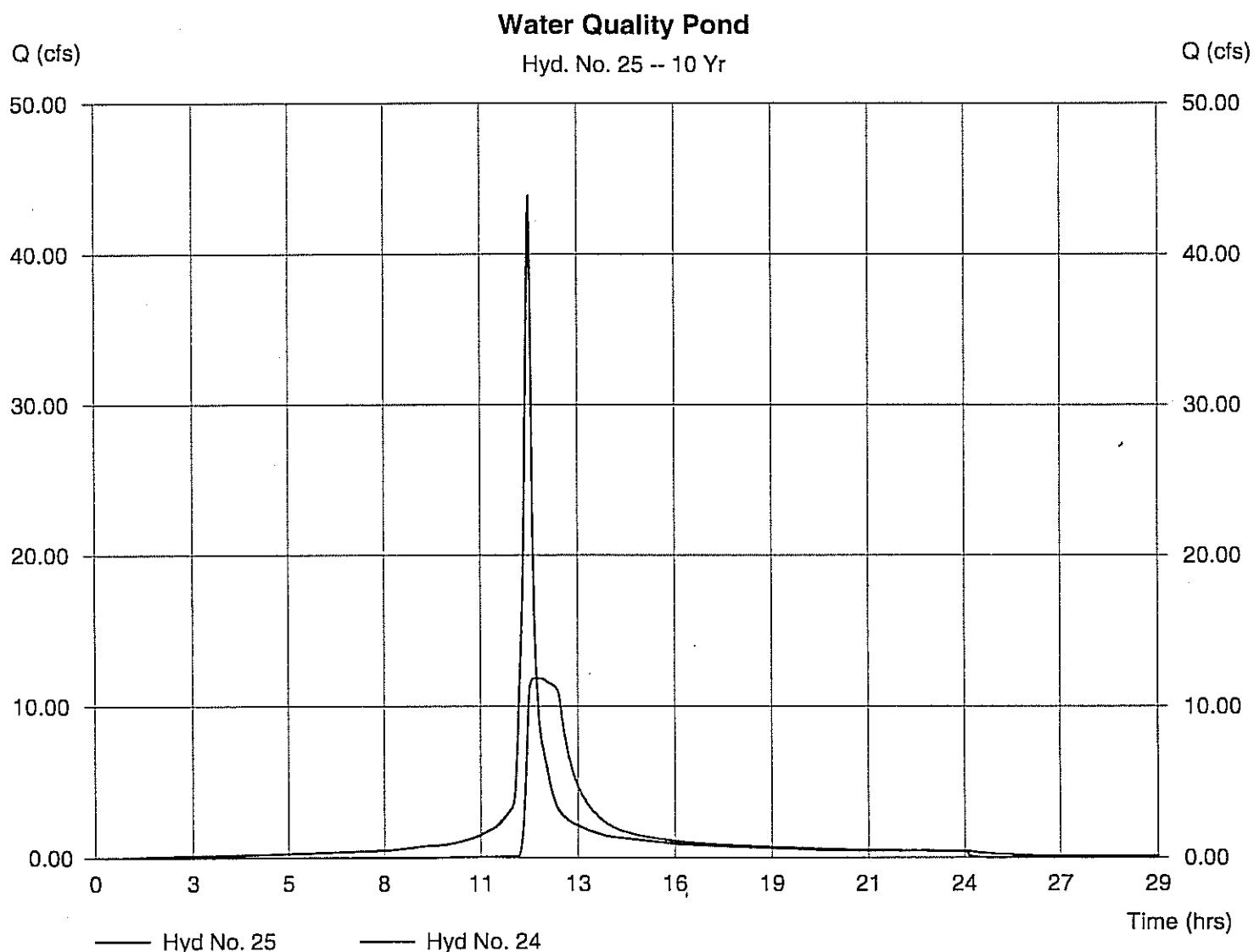
### Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 10 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

Peak discharge = 11.86 cfs  
Time interval = 2 min  
Max. Elevation = 905.58 ft  
Max. Storage = 1.802 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 2.475 acft



# Pond Report

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Pond No. 1 - Pond 2

### Pond Data

Pond storage is based on known contour areas. Conic method used.

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	895.00	1,009	0.000	0.000
1.00	896.00	1,729	0.031	0.031
2.00	897.00	2,638	0.050	0.081
3.00	898.00	3,643	0.072	0.153
4.00	899.00	4,802	0.097	0.249
5.00	900.00	6,097	0.125	0.374
6.00	901.00	7,527	0.156	0.530
7.00	902.00	9,099	0.191	0.721
8.00	903.00	12,218	0.244	0.964
9.00	904.00	13,635	0.297	1.261
10.00	905.00	15,110	0.330	1.591
11.00	906.00	16,640	0.364	1.955
12.00	907.00	18,227	0.400	2.355

### Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 15.00	2.00	0.00	0.00
Span (in)	= 15.00	2.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 899.72	902.00	0.00	0.00
Length (ft)	= 100.00	1.00	0.00	0.00
Slope (%)	= 1.00	1.00	0.00	0.00
N-Value	= .013	.013	.000	.000
Orif. Coeff.	= 0.60	0.60	0.00	0.00
Multi-Stage	= n/a	Yes	No	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 24.00	2.00	50.00	0.00
Crest El. (ft)	= 904.65	903.40	906.40	0.00
Weir Coeff.	= 3.33	3.33	3.33	0.00
Weir Type	= Riser	Riser	Ciptli	--
Multi-Stage	= Yes	Yes	No	No

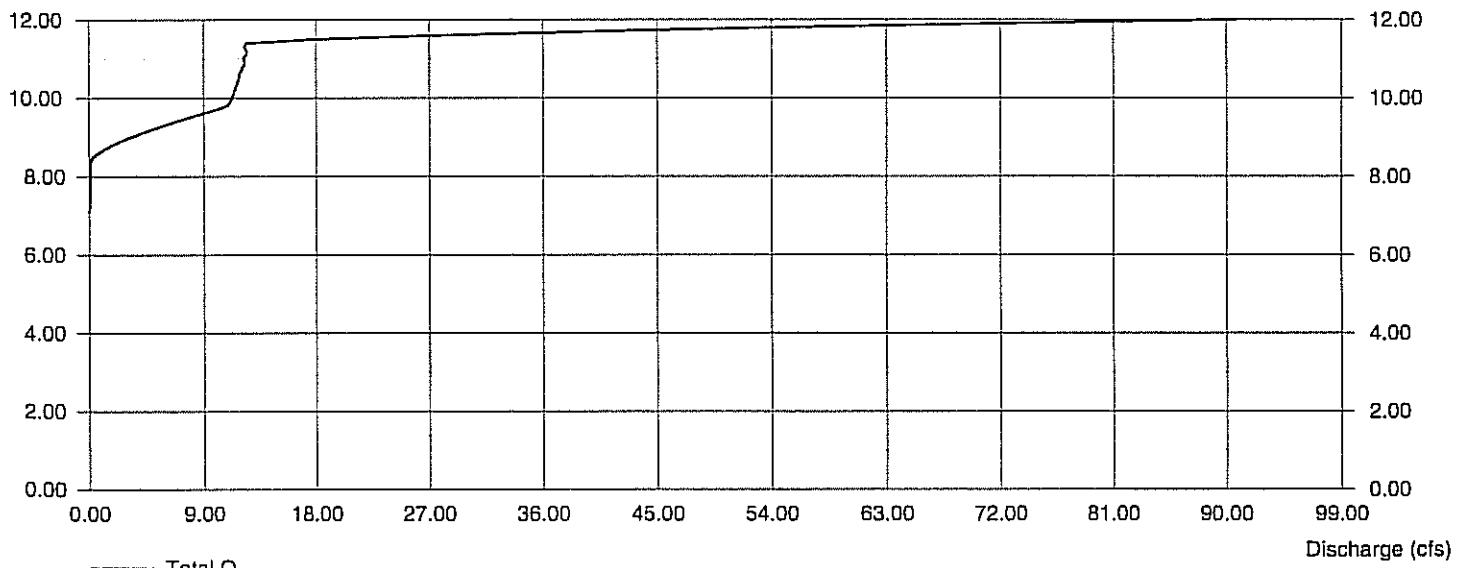
Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control.

Stage (ft)

### Stage / Discharge

Stage (ft)



# Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 26

WQ Pond Outfall

Hydrograph type = Reach  
Storm frequency = 10 yrs  
Inflow hyd. No. = 25  
Reach length = 500.0 ft  
Manning's n = 0.009  
Side slope = 0.0:1  
Rating curve x = 3.023  
Ave. velocity = 6.71 ft/s

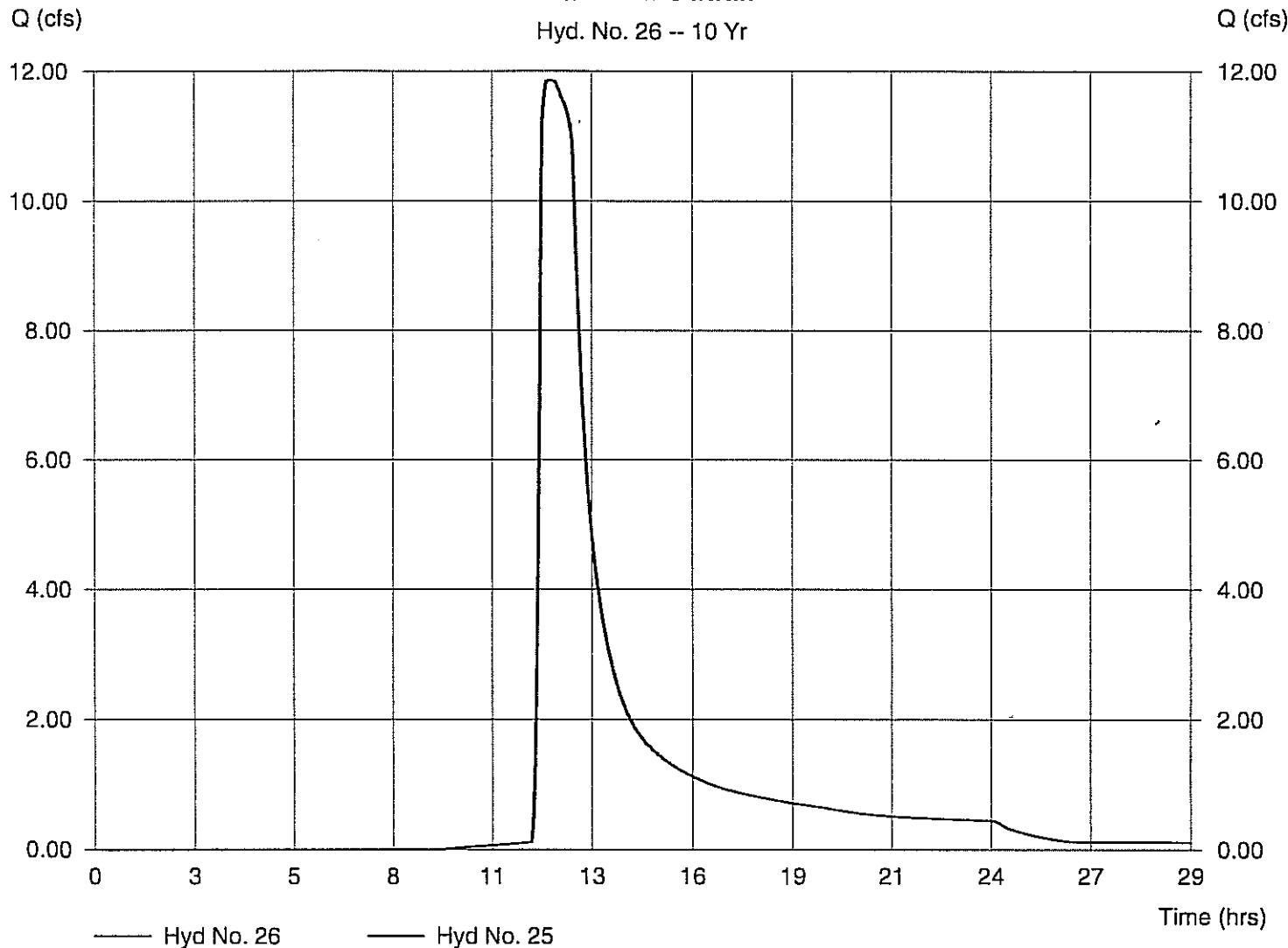
Peak discharge = 11.86 cfs  
Time interval = 2 min  
Section type = Circular  
Channel slope = 0.1 %  
Bottom width = 1.5 ft  
Max. depth = 0.0 ft  
Rating curve m = 1.250  
Routing coeff. = 1.0033

Modified Att-Kin routing method used.

Hydrograph Volume = 2.473 acft

### WQ Pond Outfall

Hyd. No. 26 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

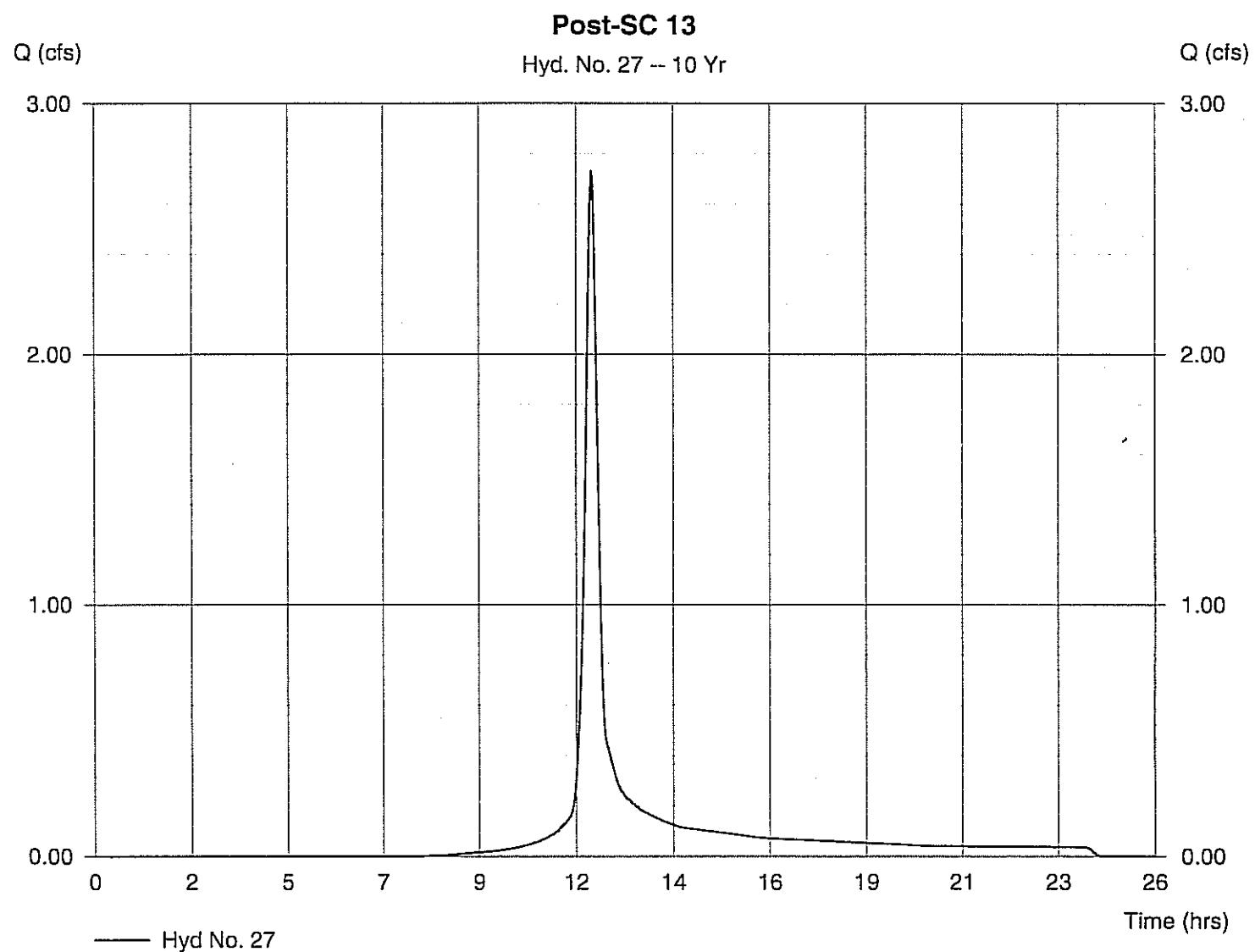
## Hyd. No. 27

Post-SC 13

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.71 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.73 cfs  
Time interval = 2 min  
Curve number = 77  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 14.7 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.176 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

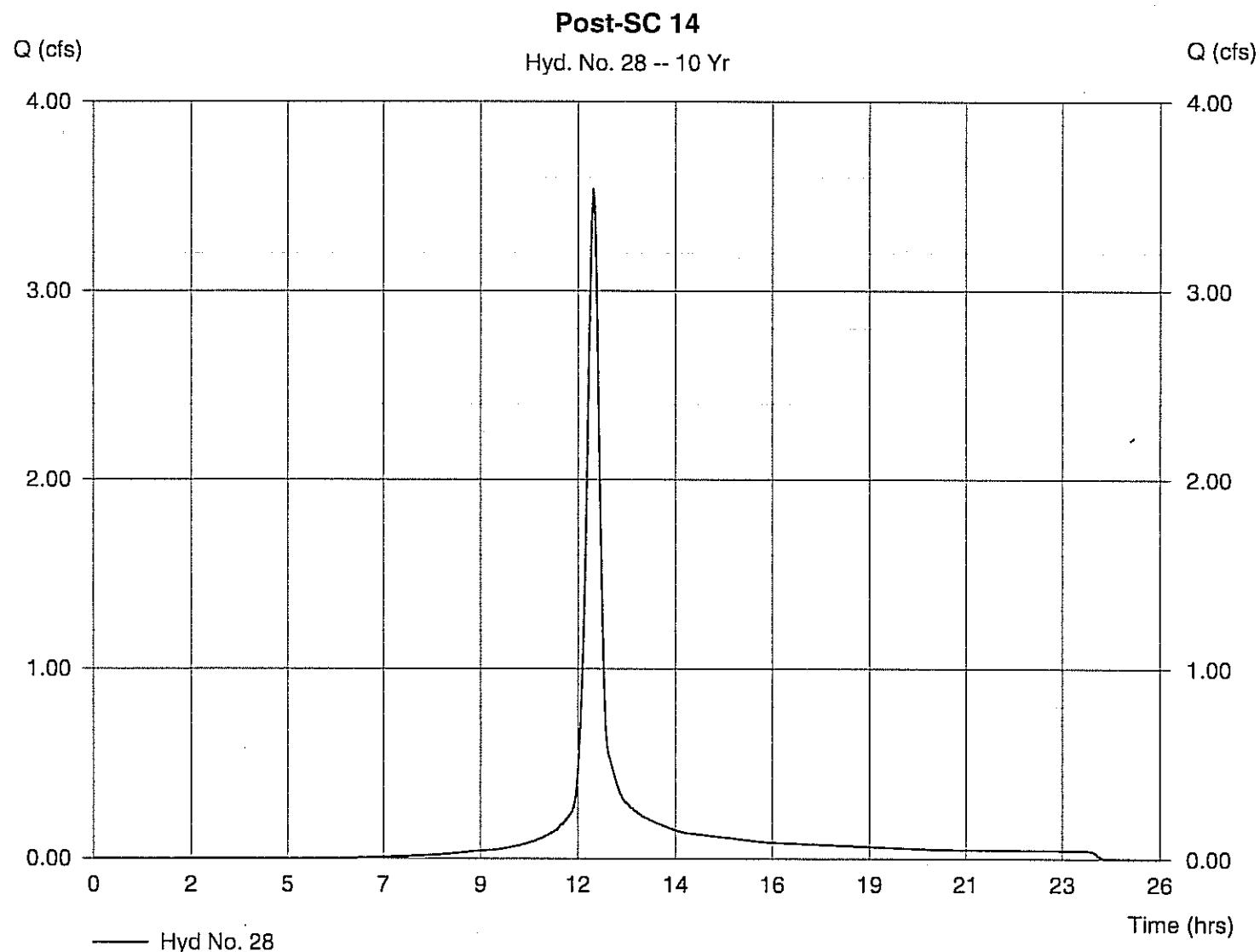
## Hyd. No. 28

Post-SC 14

Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.78 ac  
Basin Slope = 0.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 3.54 cfs  
Time interval = 2 min  
Curve number = 83  
Hydraulic length = 0 ft  
Time of conc. (Tc) = 14.7 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.230 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 29

Burnt Poplar Drive Culvert

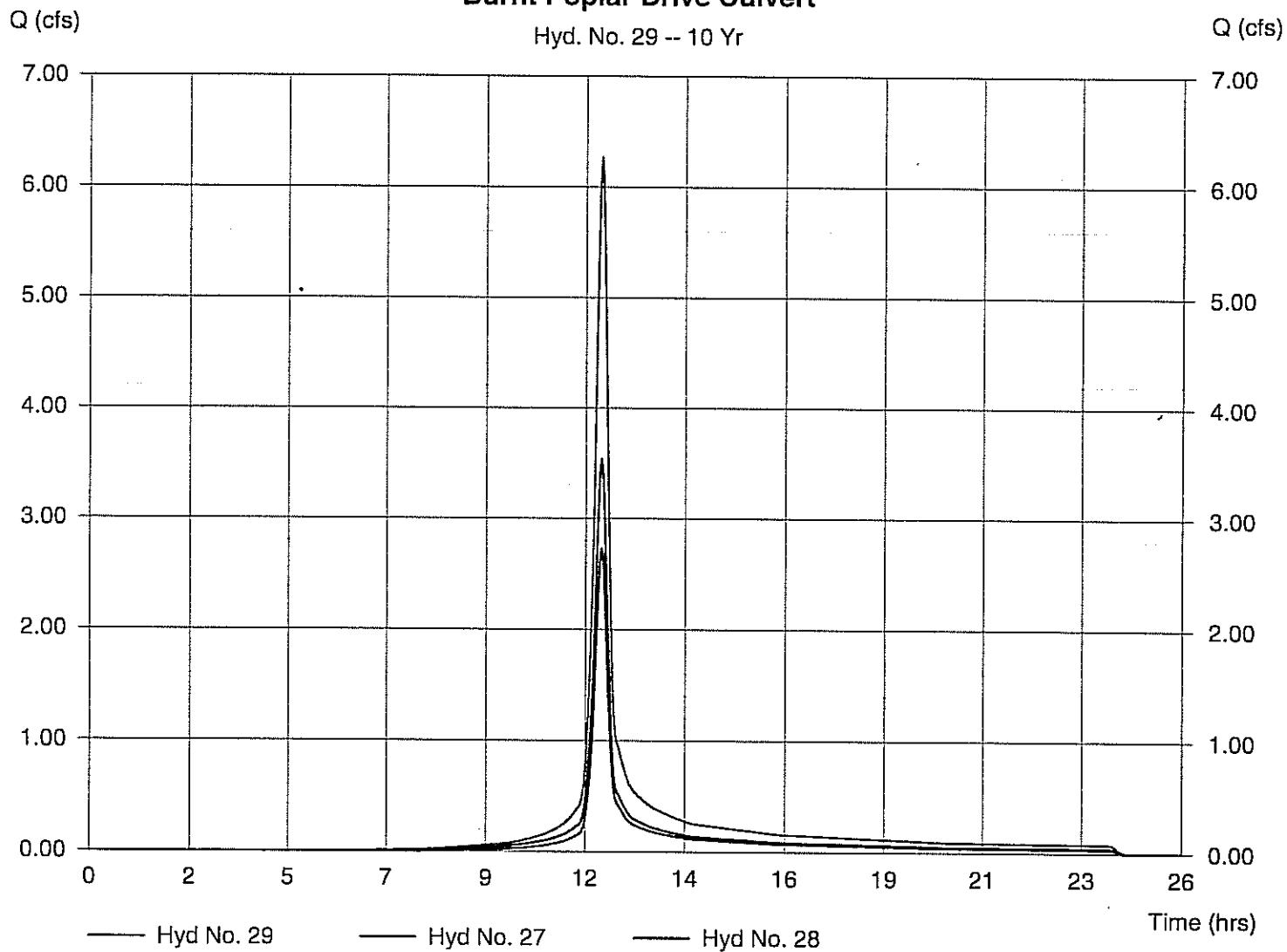
Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 27, 28

Peak discharge = 6.27 cfs  
Time interval = 2 min

Hydrograph Volume = 0.406 acft

### Burnt Poplar Drive Culvert

Hyd. No. 29 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 5:46 PM

## Hyd. No. 30

North Area - Post-SC 15

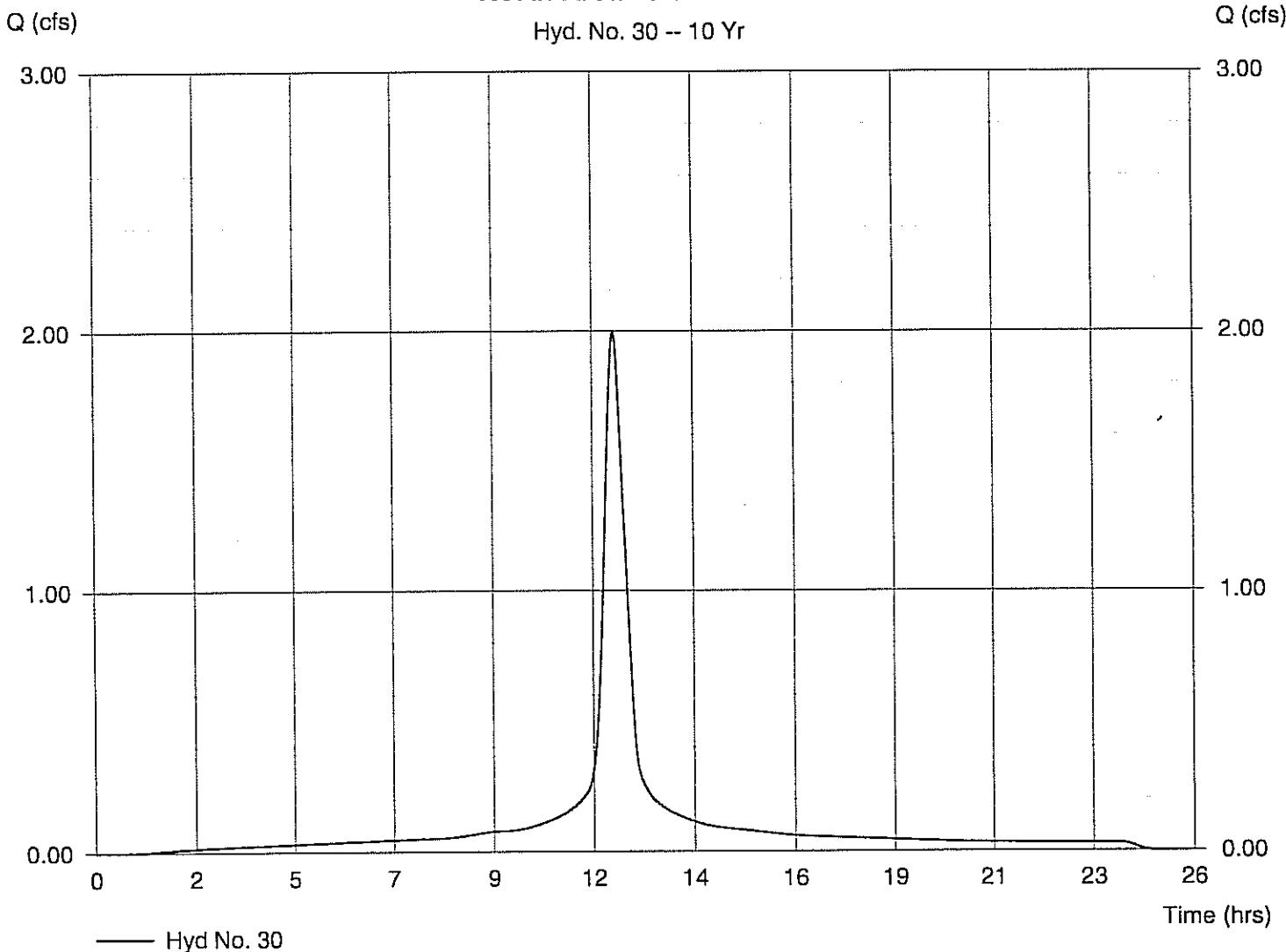
Hydrograph type = SCS Runoff  
Storm frequency = 10 yrs  
Drainage area = 0.47 ac  
Basin Slope = 4.0 %  
Tc method = TR55  
Total precip. = 5.50 in  
Storm duration = 24 hrs

Peak discharge = 2.00 cfs  
Time interval = 2 min  
Curve number = 98  
Hydraulic length = 700 ft  
Time of conc. (Tc) = 28.5 min  
Distribution = Type II  
Shape factor = 484

Hydrograph Volume = 0.206 acft

### North Area - Post-SC 15

Hyd. No. 30 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 5:46 PM

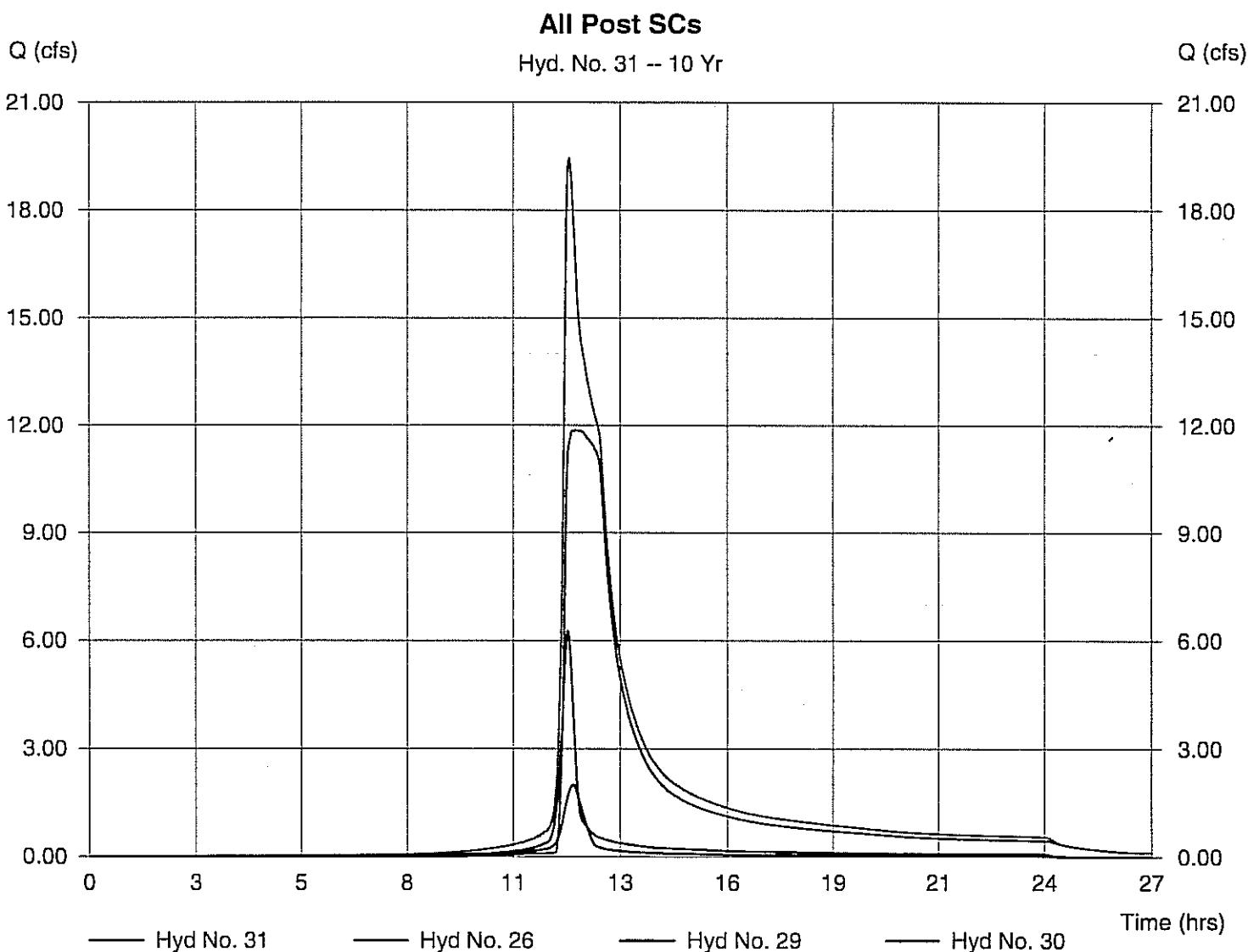
## Hyd. No. 31

All Post SCs

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 26, 29, 30

Peak discharge = 19.45 cfs  
Time interval = 2 min

Hydrograph Volume = 3.085 acft



# Hydrograph Plot

Hydraflow Hydrographs by Intellisolve

Wednesday, Mar 24 2004, 5:46 PM

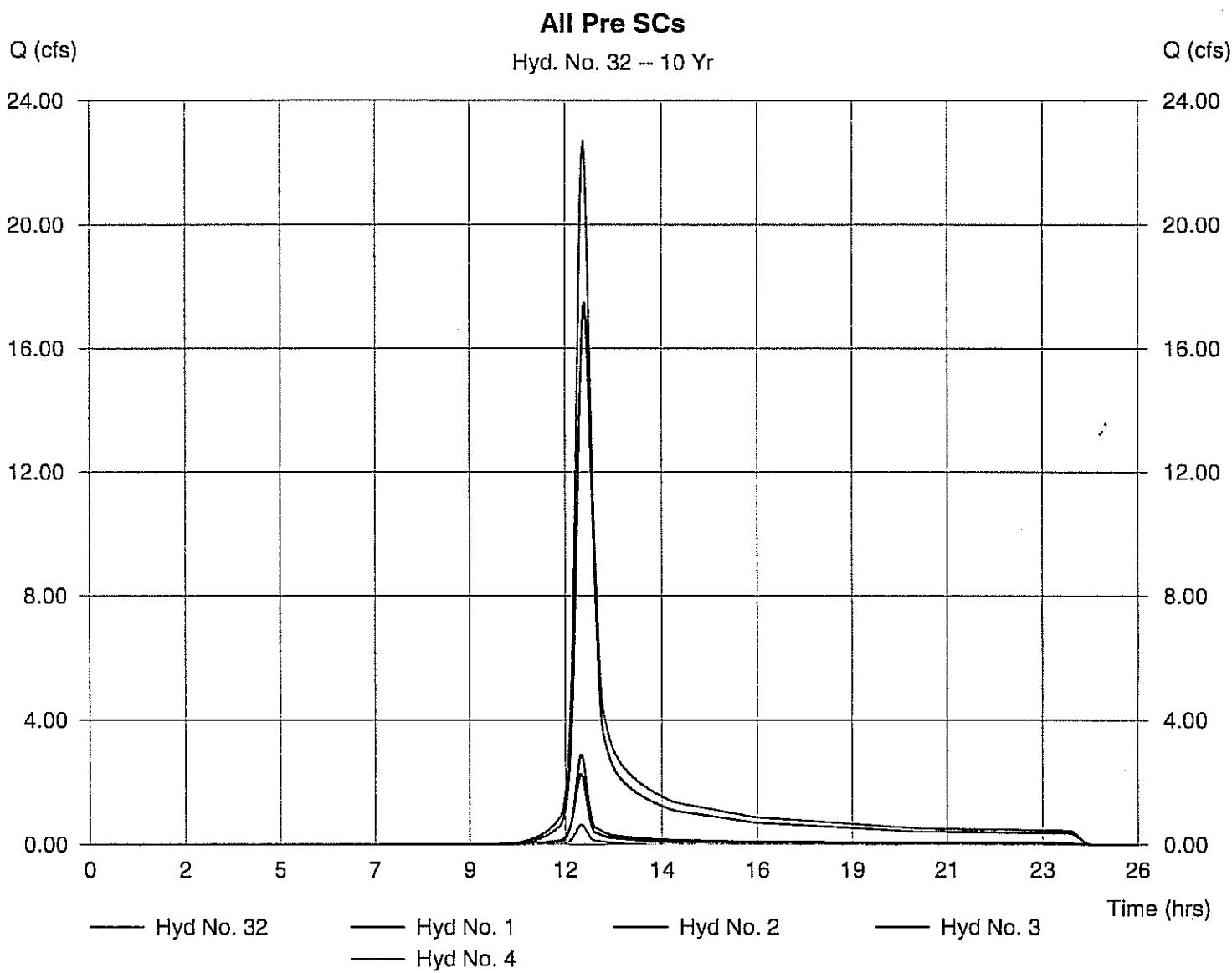
## Hyd. No. 32

All Pre SCs

Hydrograph type = Combine  
Storm frequency = 10 yrs  
Inflow hyds. = 1, 2, 3, 4

Peak discharge = 22.71 cfs  
Time interval = 2 min

Hydrograph Volume = 1.811 acft



## **Water Quality Pond (Routing) 1-, 2-, 10-, 25-, and 100-Year Events**

# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 6:14 PM

## Hyd. No. 25

### Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 1 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

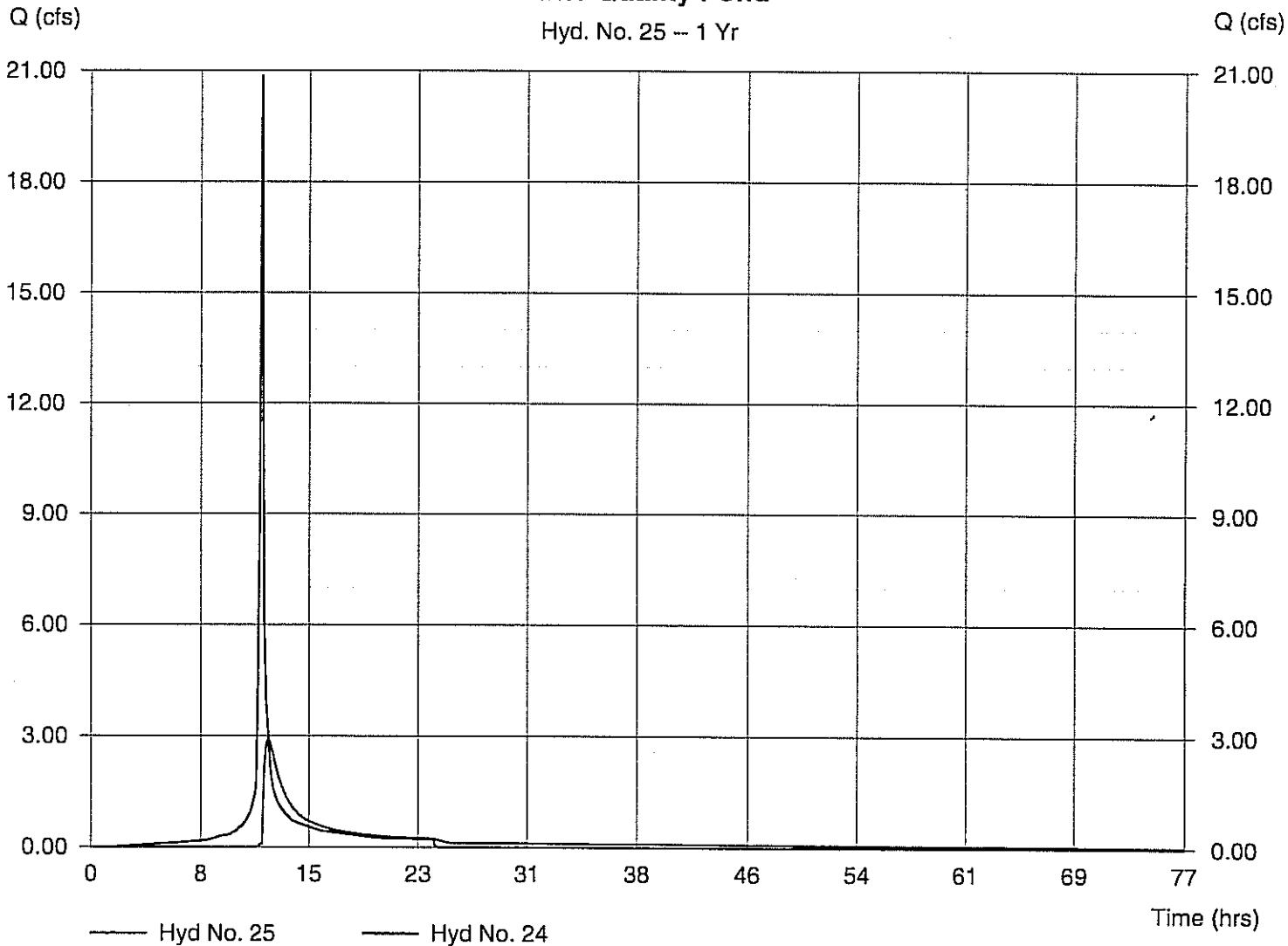
Peak discharge = 2.91 cfs  
Time interval = 2 min  
Max. Elevation = 903.96 ft  
Max. Storage = 1.248 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 1.060 acft

### Water Quality Pond

Hyd. No. 25 -- 1 Yr



# Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 6:14 PM

## Hyd. No. 25

### Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 2 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

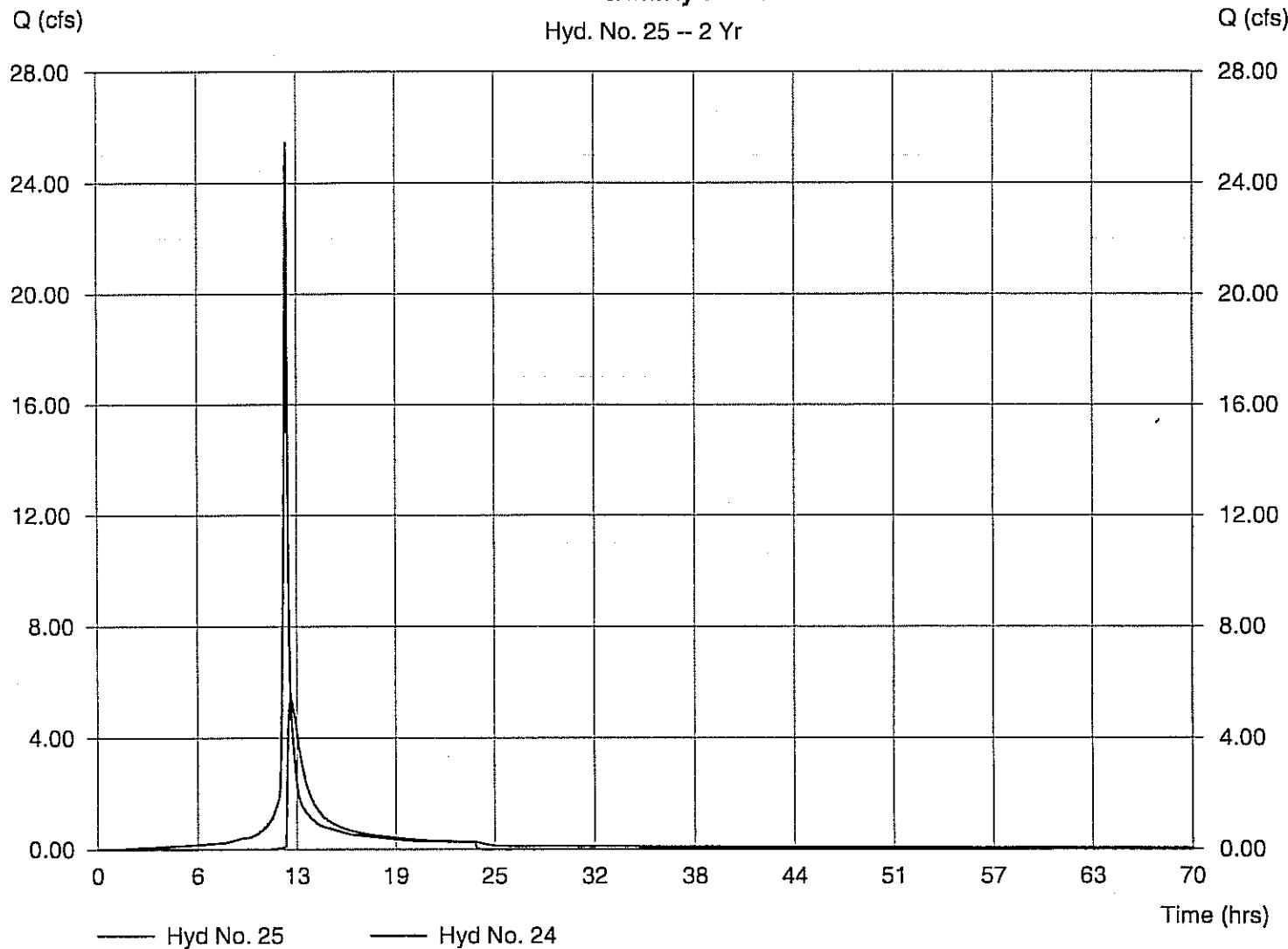
Peak discharge = 5.39 cfs  
Time interval = 2 min  
Max. Elevation = 904.25 ft  
Max. Storage = 1.344 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 1.335 acft

Water Quality Pond

Hyd. No. 25 -- 2 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 6:14 PM

## Hyd. No. 25

Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 10 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

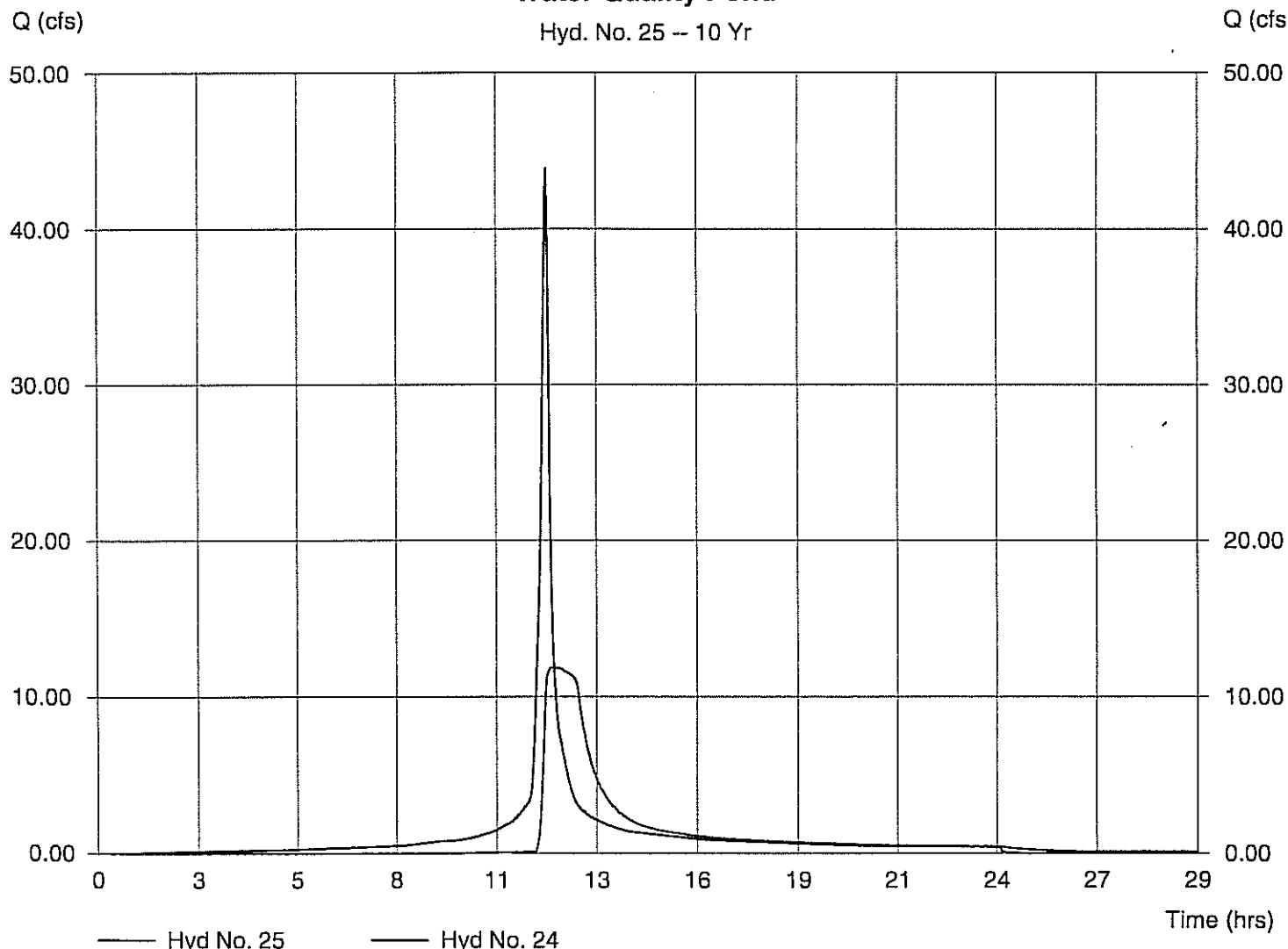
Peak discharge = 11.86 cfs  
Time interval = 2 min  
Max. Elevation = 905.58 ft  
Max. Storage = 1.802 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 2.475 acft

Water Quality Pond

Hyd. No. 25 -- 10 Yr



# Hydrograph Plot

Hydraflow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 6:14 PM

## Hyd. No. 25

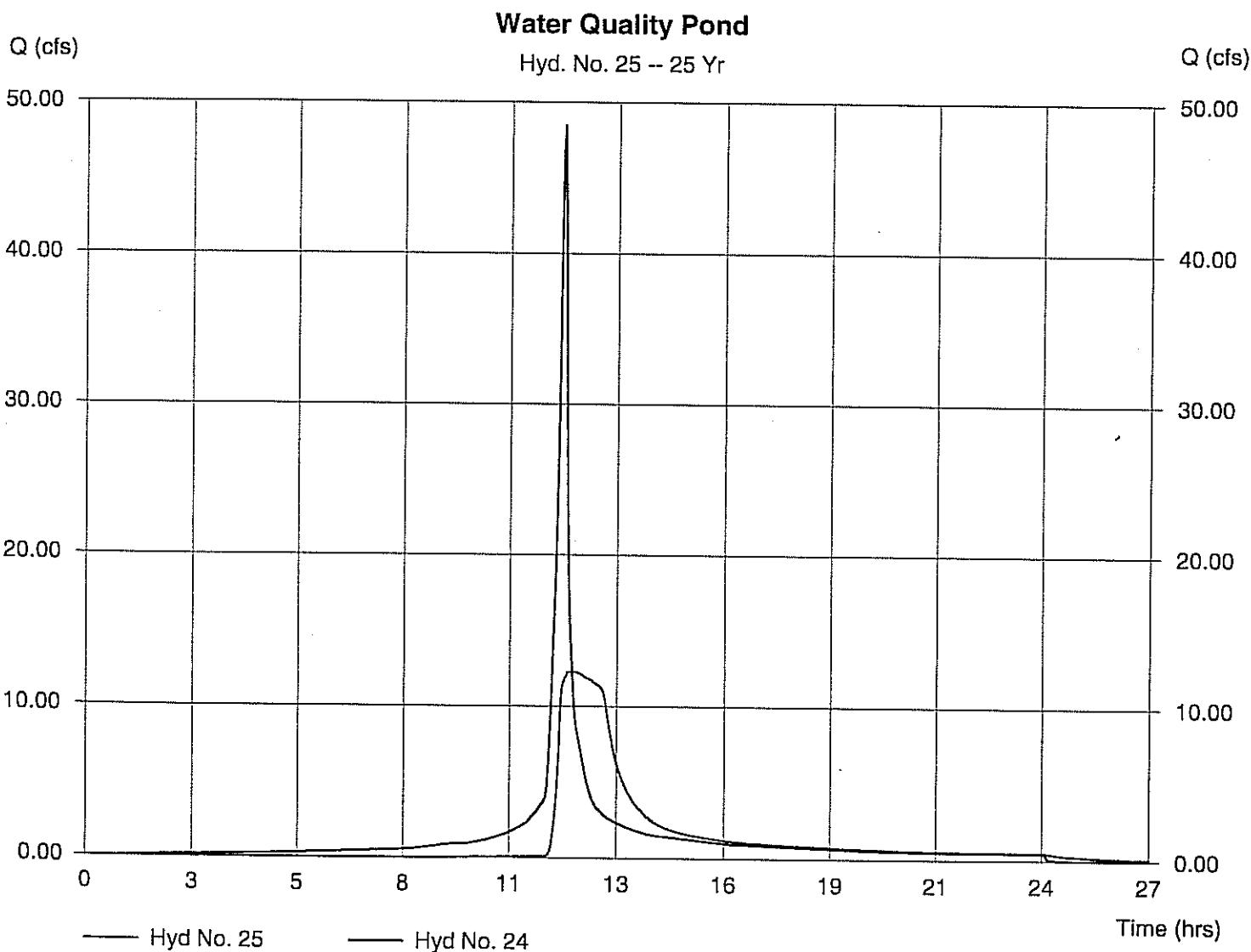
Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 25 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

Peak discharge = 12.28 cfs  
Time interval = 2 min  
Max. Elevation = 905.89 ft  
Max. Storage = 1.933 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 2.765 acft



# Hydrograph Plot

Hydralow Hydrographs by Intelsolve

Wednesday, Mar 24 2004, 6:14 PM

## Hyd. No. 25

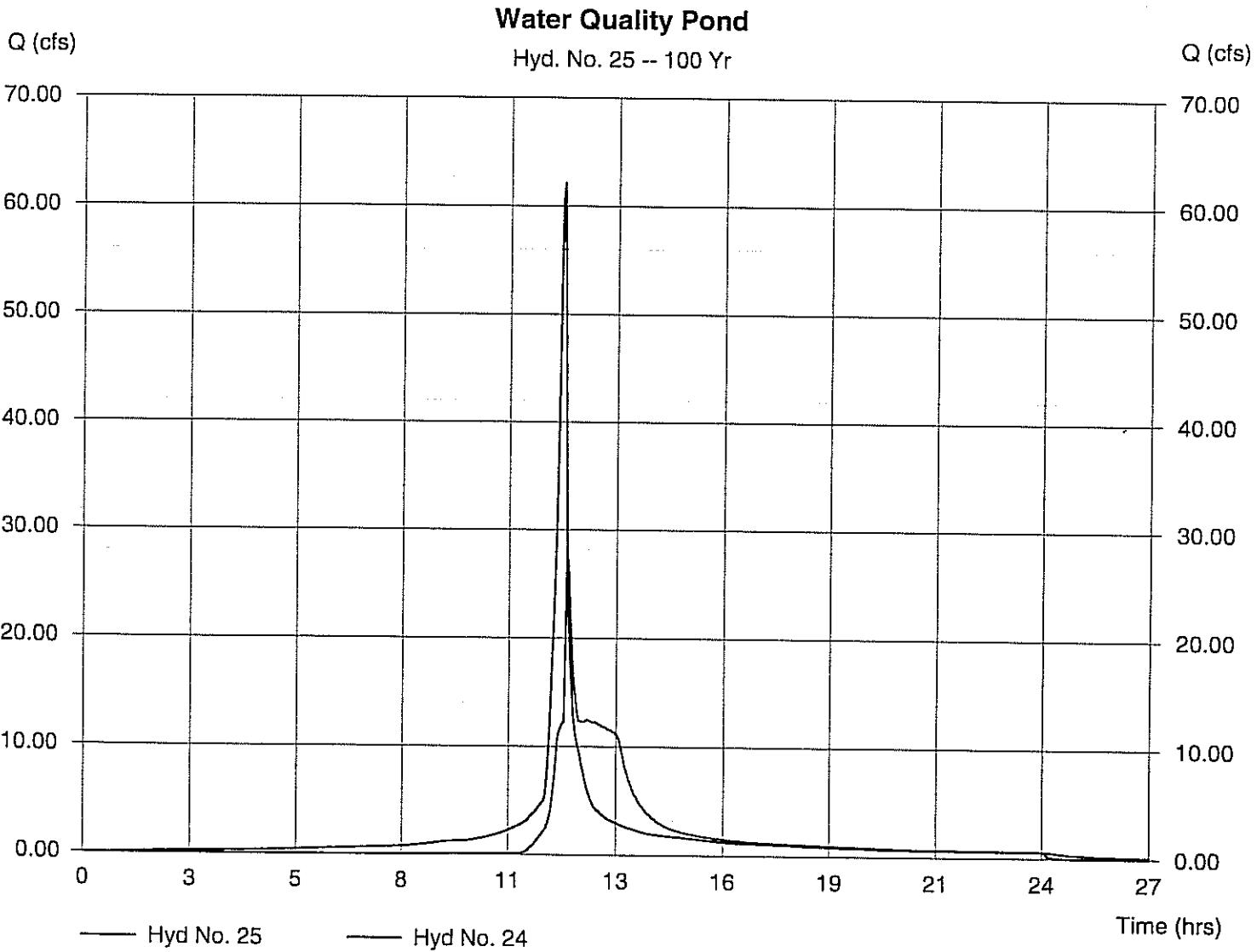
### Water Quality Pond

Hydrograph type = Reservoir  
Storm frequency = 100 yrs  
Inflow hyd. No. = 24  
Reservoir name = Pond 2

Peak discharge = 27.95 cfs  
Time interval = 2 min  
Max. Elevation = 906.61 ft  
Max. Storage = 2.198 acft

Storage Indication method used. Wet pond routing start elevation = 901.00 ft.

Hydrograph Volume = 3.645 acft



# **Pond Report**

# Pond Report

Hydraflow Hydrographs by InteliSolve

Wednesday, Mar 24 2004, 6:26 PM

## Pond No. 1 - Pond 2

### Pond Data

Pond storage is based on known contour areas. Conic method used.

### Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	895.00	1,009	0.000	0.000
1.00	896.00	1,729	0.031	0.031
2.00	897.00	2,638	0.050	0.081
3.00	898.00	3,643	0.072	0.153
4.00	899.00	4,802	0.097	0.249
5.00	900.00	6,097	0.125	0.374
6.00	901.00	7,527	0.156	0.530
7.00	902.00	9,099	0.191	0.721
8.00	903.00	12,218	0.244	0.964
9.00	904.00	13,635	0.297	1.261
10.00	905.00	15,110	0.330	1.591
11.00	906.00	16,640	0.364	1.955
12.00	907.00	18,227	0.400	2.355

### Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 15.00	2.00	0.00	0.00
Span (in)	= 15.00	2.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 899.72	902.00	0.00	0.00
Length (ft)	= 100.00	1.00	0.00	0.00
Slope (%)	= 1.00	1.00	0.00	0.00
N-Value	= .013	.013	.000	.000
Orif. Coeff.	= 0.60	0.60	0.00	0.00
Multi-Stage	= n/a	Yes	No	No

### Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 24.00	2.00	50.00	0.00
Crest El. (ft)	= 904.65	903.40	906.40	0.00
Weir Coeff.	= 3.33	3.33	3.33	0.00
Weir Type	= Riser	Riser	Cipti	---
Multi-Stage	= Yes	Yes	No	No

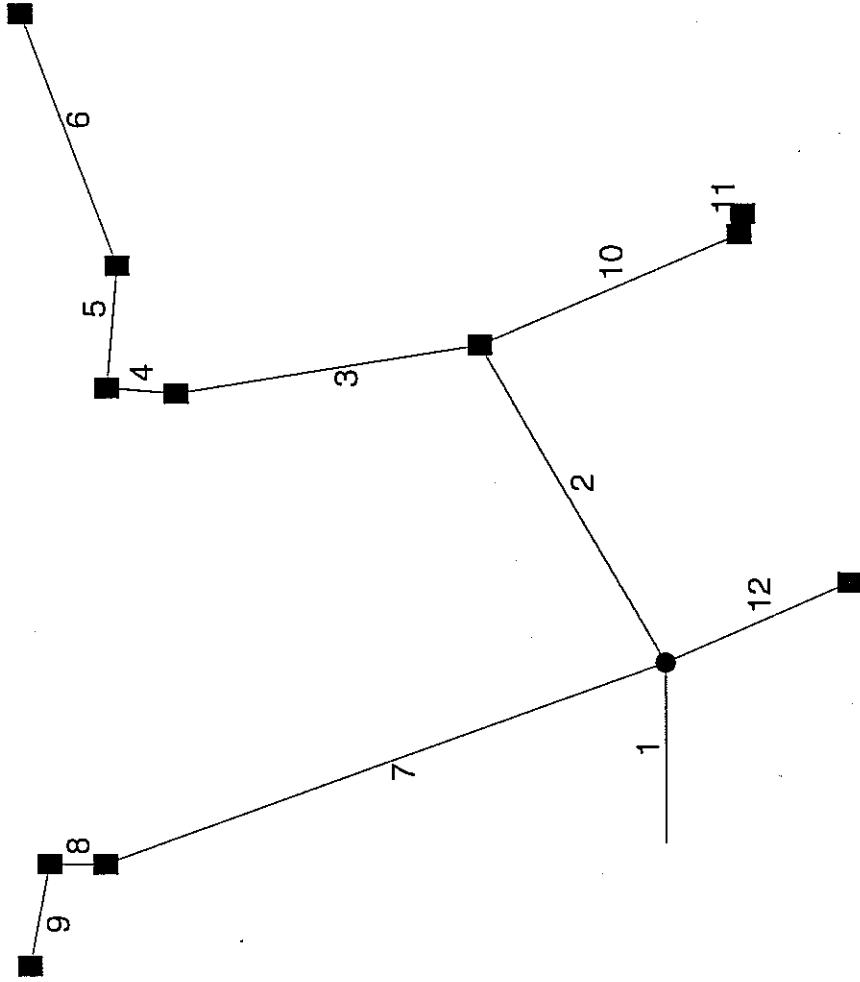
Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

### Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Civ A cfs	Civ B cfs	Civ C cfs	Civ D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0.000	895.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
1.00	0.031	896.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
2.00	0.081	897.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
3.00	0.153	898.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
4.00	0.249	899.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
5.00	0.374	900.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
6.00	0.530	901.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
7.00	0.721	902.00	0.00	0.00	---	---	0.00	0.00	0.00	---	---	0.00
8.00	0.964	903.00	0.10	0.10	---	---	0.00	0.00	0.00	---	---	0.10
9.00	1.261	904.00	3.27	0.15	---	---	0.00	3.10	0.00	---	---	3.24
10.00	1.591	905.00	11.29	0.02	---	---	7.73	3.53	0.00	---	---	11.28
11.00	1.955	906.00	12.40	0.00	---	---	10.39	1.80	0.00	---	---	12.19
12.00	2.355	907.00	13.39	0.00	---	---	11.78	1.58	77.38	---	---	90.74

**Stormdrain Collection System Design – Hydraflow  
Storm Sewers 2000, by Intelisolve**

## Hydraflow Plan View



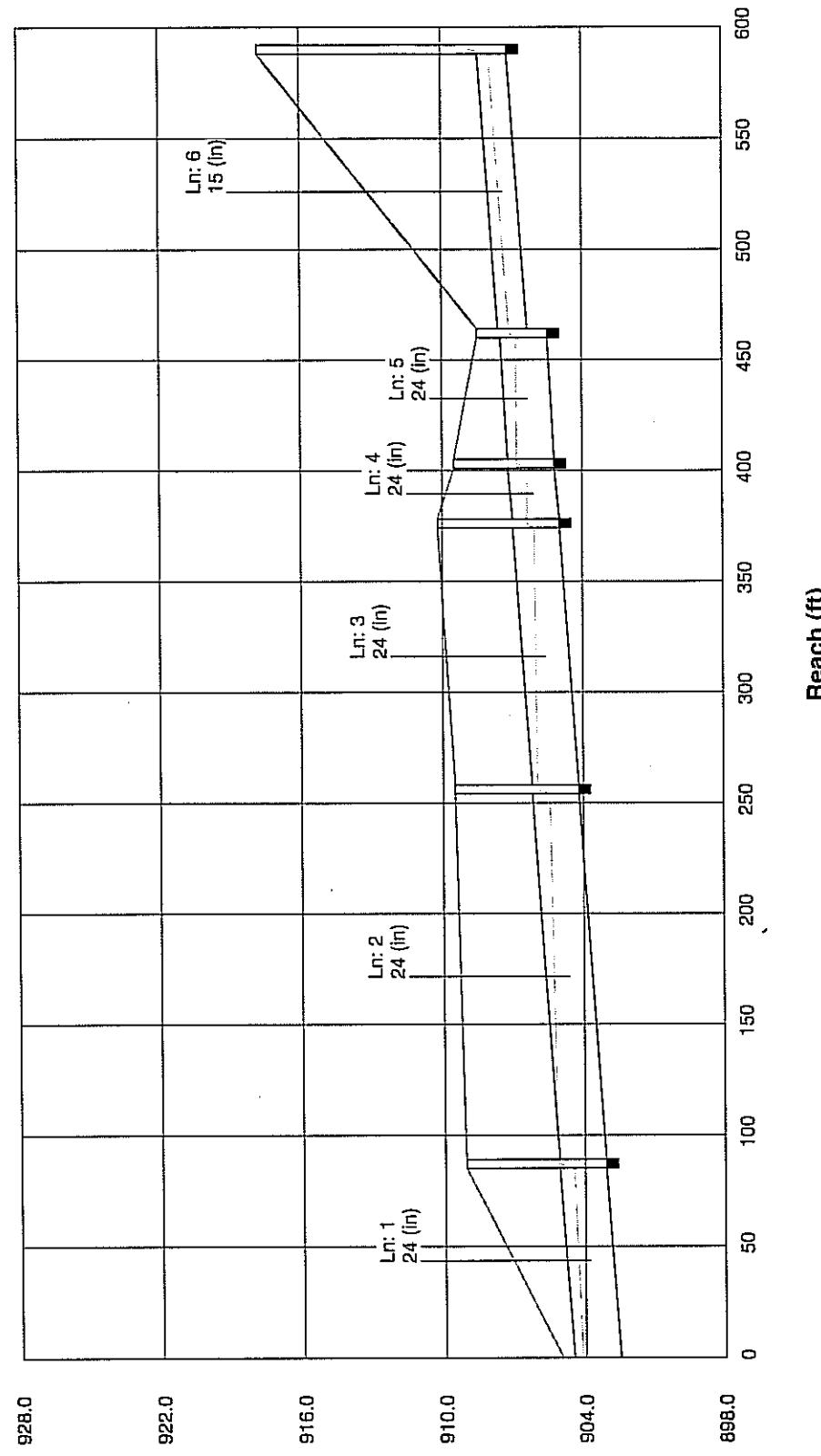
Project file: Storm Drain DI#1 - 11.stm

IDF file: Greensboro NC Hydro 35 for Storm Pipes.IDf. Lines: 12

03-26-2004

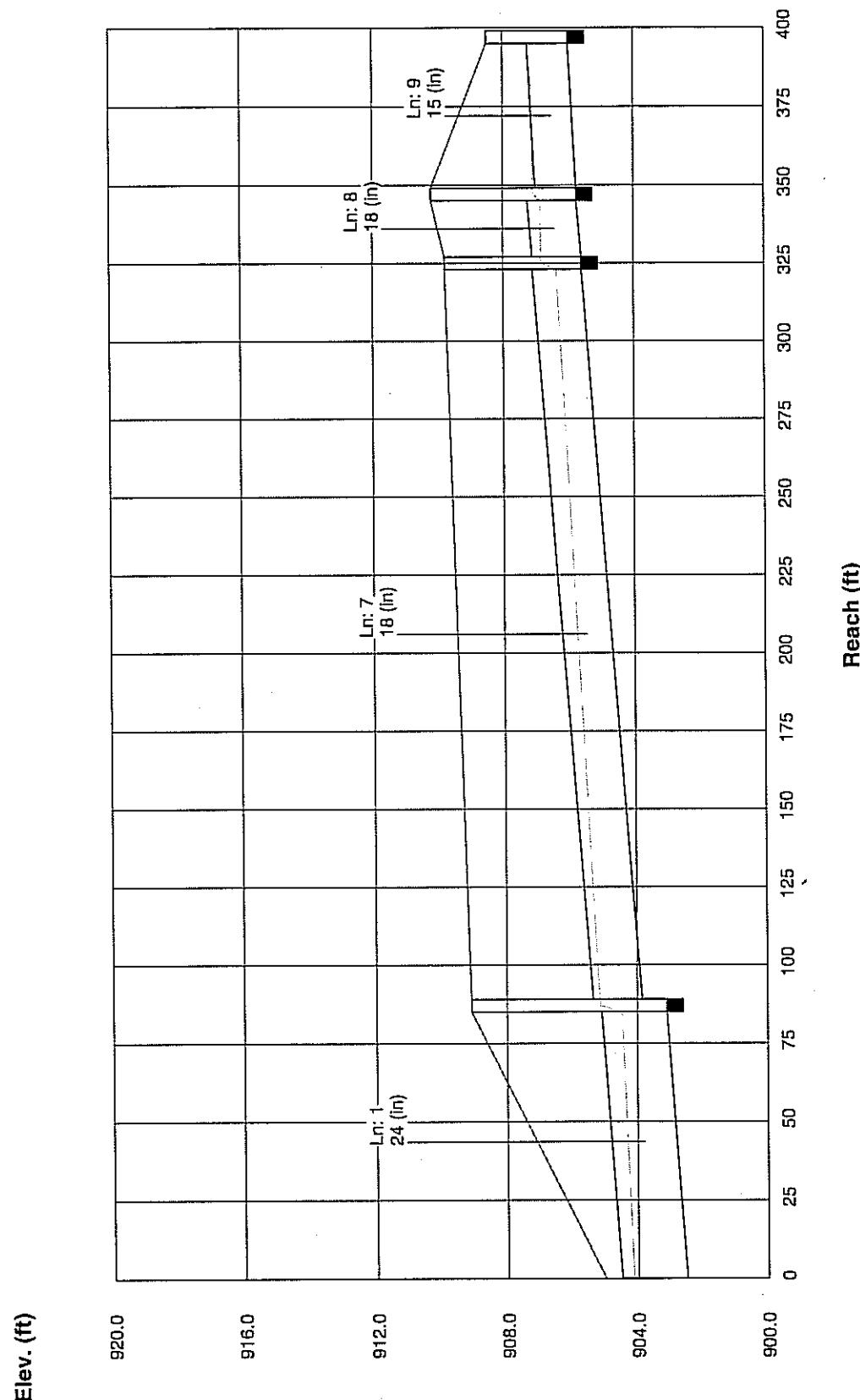
# Storm Sewer Profile

Elev. (ft)



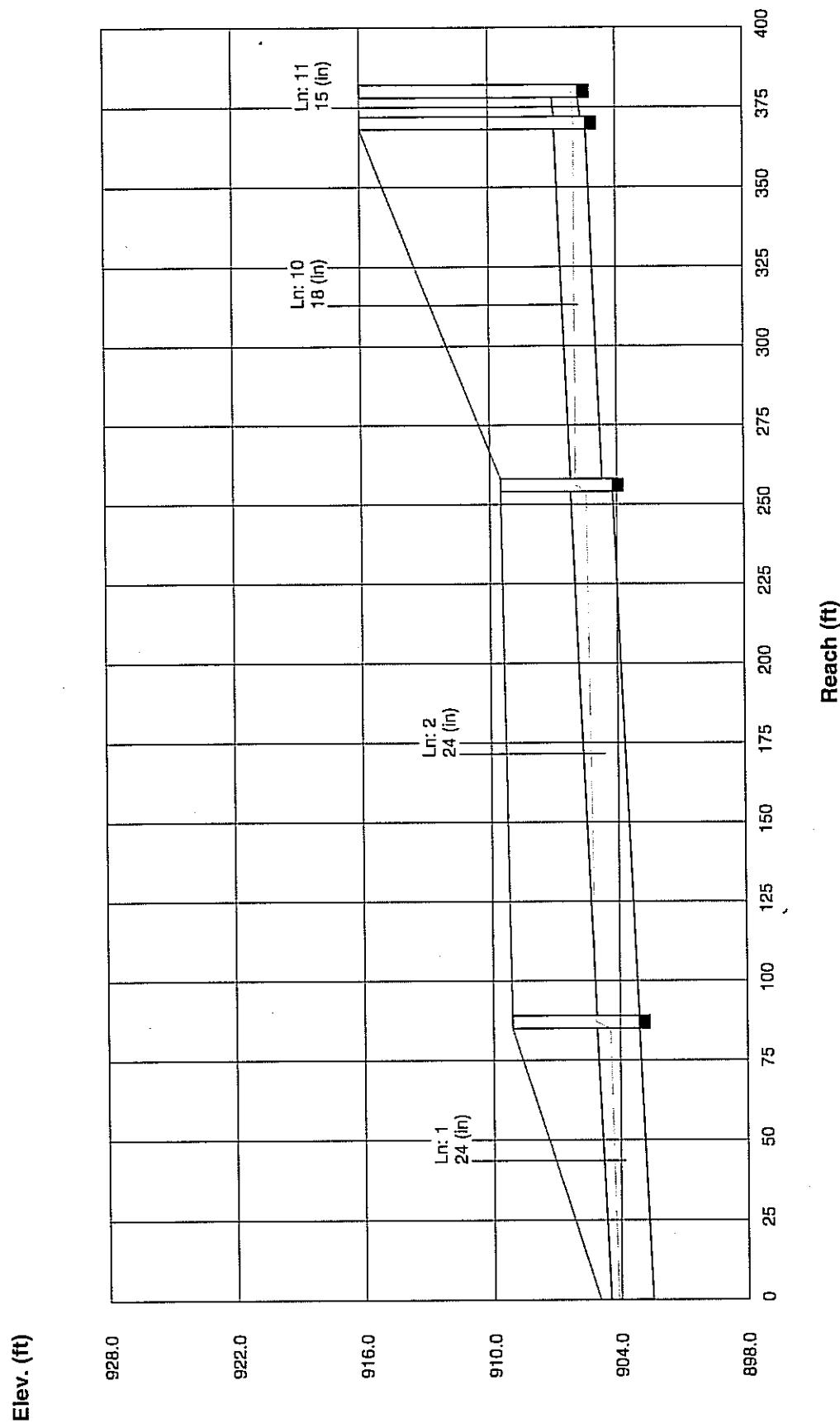
# Storm Sewer Profile

Proj. file: Storm Drain Diff - H.sum

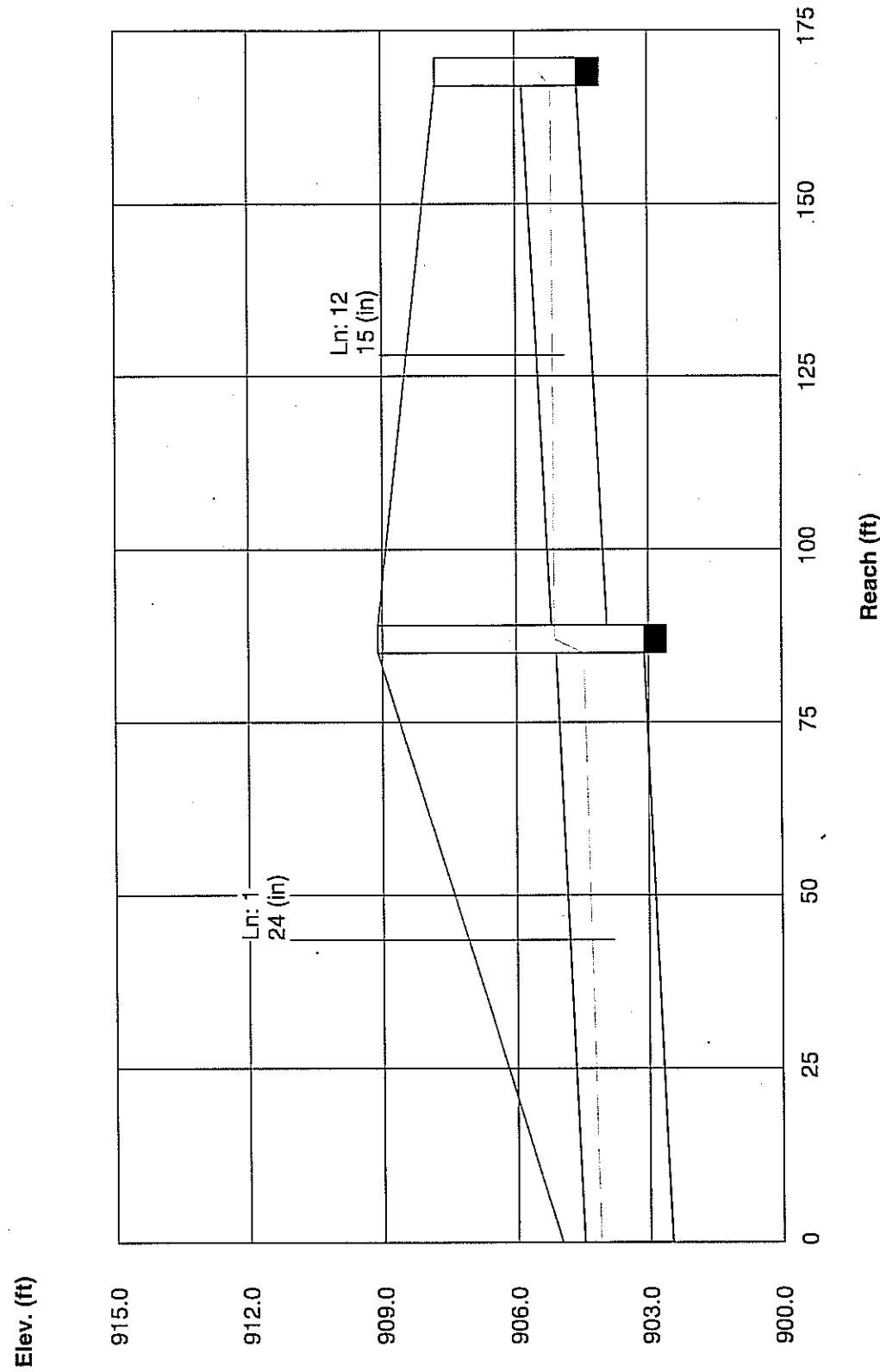


# Storm Sewer Profile

Proj. file: Storm Drain D#1 - H1.gtm



# Storm Sewer Profile



# Hydraflow Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data				Line ID				
	Drstr Line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Line size (in)	Line type	N value (n)	J-loss coeff (K)	Inlet/Rim El (ft)		
1	End	87.0	0.0	MH	0.00	0.00	0.00	0.0	902.50	0.69	903.10	24	Cir	0.013	1.00	909.10	Pond to DMH1
2	1	169.0	-25.0	DrGrT	0.00	0.32	0.41	10.0	903.10	0.65	904.20	24	Cir	0.013	1.30	909.50	DMH1 to Di2
3	2	120.0	-76.0	DrGrT	0.00	0.26	0.53	8.0	904.20	0.67	905.00	24	Cir	0.013	0.70	910.20	Di2 to Di3
4	3	27.0	17.0	DrGrT	0.00	0.88	0.53	10.0	905.00	0.74	905.20	24	Cir	0.013	1.50	909.50	Di3 to Di4
5	4	59.0	88.0	DrGrT	0.00	0.58	0.53	10.0	905.20	0.51	905.50	24	Cir	0.013	0.70	909.50	Di 4 to Di 5
6	5	128.0	-21.0	DrGrT	0.00	0.86	0.64	10.0	906.35	0.66	907.20	15	Cir	0.013	2.50	917.80	Di 5 to Di 6
7	1	238.0	-114.0	DrGrT	0.00	0.18	0.59	2.0	903.85	0.74	905.60	18	Cir	0.013	1.50	909.80	DMH1 to Di 9
8	7	22.0	25.0	DrGrT	0.00	0.17	0.59	10.0	905.60	0.68	905.75	18	Cir	0.013	2.50	910.20	Di 9 to Di 10
9	8	50.0	-82.0	DrGrT	0.00	0.70	0.59	10.0	905.75	0.50	906.00	15	Cir	0.013	0.00	908.50	Di10 to Di 11
10	2	114.0	87.0	DrGrT	0.00	0.04	0.52	2.0	904.70	0.61	905.40	18	Cir	0.013	0.00	916.00	Di 2 to Di 7
11	10	10.0	-54.0	DrGrT	0.00	0.13	0.52	2.0	905.65	1.00	905.75	15	Cir	0.013	0.00	916.00	Di 7 TO Di 8
12	1	82.0	62.0	DrGrT	0.00	0.42	0.43	4.0	903.95	0.79	904.60	15	Cir	0.013	2.50	907.80	DMH1 to Di 1

# Hydraflow Summary Report

Page 1

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	Pond to DMH1	15.06	24 c	87.0	902.50	903.10	0.690	904.13	904.47	0.67	End
2	DMH1 to DI2	10.48	24 c	169.0	903.10	904.20	0.651	905.14	905.45	0.52	1
3	DI2 to DI3	9.31	24 c	120.0	904.20	905.00	0.667	905.97	906.09	0.31	2
4	DI3 to DI4	8.48	24 c	27.0	905.00	905.20	0.741	906.40	906.36	0.47	3
5	DI 4 to DI 5	5.60	24 c	59.0	905.20	905.50	0.508	906.83	906.84	0.07	4
6	DI 5 to DI 6	3.68	15 c	128.0	906.35	907.20	0.664	907.13	907.97	0.83	5
7	DMH1 to DI 9	4.06	18 c	238.0	903.85	905.60	0.735	905.14	906.37	0.46	1
8	DI 9 to DI 10	3.39	18 c	22.0	905.60	905.75	0.682	906.83	906.84	0.24	7
9	DI10 to DI 11	2.76	15 c	50.0	905.75	906.00	0.500	907.07	907.15	0.00	8
10	DI 2 to DI 7	0.82	18 c	114.0	904.70	905.40	0.614	905.97	905.99	0.00	2
11	DI 7 TO DI 8	0.64	15 c	10.0	905.65	905.75	1.000	905.99	906.07	0.00	10
12	DMH1 to DI 1	1.54	15 c	82.0	903.95	904.60	0.793	905.14	905.19	0.29	1

Project File: Storm Drain DI#1 - 11.stm IDF File: Greensboro NC Hydro 35 Total No. Lines: 12 Run Date: 03-26-2004

NOTES: c = circular; e = elliptical; b = box; Return period = 25 Yrs.; \* Indicates surcharge condition.

# Hydroflow Inlet Report

Page 1

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q bypass (cfs)	Curb Inlet			Grate Inlet			Gutter			Inlet depth (ft)	spread (ft)	Dep (in)	Byp line No	
						Ht (in)	L (ft)	Junc type	area (sqft)	L (ft)	W (ft)	S <sub>o</sub> (ft/ft)	W (ft)	S <sub>w</sub> (ft/ft)	S <sub>x</sub> (ft/ft)	n	depth (ft)		
1	Cover	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	0.000	0.000	0.013	0.00	0.00	0.0	Off	
2	1	0.88	0.00	0.88	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.14	4.29	0.0	Off
3	2	0.99	0.00	0.99	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.16	4.48	0.0	Off
4	3	3.12	0.00	3.12	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.34	7.39	0.0	Off
5	4	2.06	0.00	2.06	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.25	6.04	0.0	Off
6	5	3.68	0.00	3.68	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.47	9.50	0.0	Off
7	1	1.00	0.00	1.00	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.16	4.50	0.0	Off
8	7	0.67	0.00	0.67	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.12	3.91	0.0	Off
9	8	2.76	0.00	2.76	0.00	DrGrT	0.0	0.00	0.77	4.00	Sag	2.00	0.050	0.050	0.000	0.44	19.69	0.0	Off
10	2	0.20	0.00	0.20	0.00	DrGrT	0.0	0.00	0.61	4.00	Sag	2.00	0.050	0.050	0.000	0.04	3.62	0.0	Off
11	10	0.64	0.00	0.64	0.00	DrGrT	0.0	0.00	0.58	4.00	Sag	2.00	0.050	0.050	0.000	0.09	5.56	0.0	Off
12	1	1.54	0.00	1.54	0.00	DrGrT	0.0	0.00	1.00	1.80	Sag	2.00	0.125	0.125	0.000	0.21	5.33	0.0	Off

Project File: Storm Drain D#1 - 11.slm

I-D-F File: Greensboro NC Hydro 35 for Storm Pipes.ldf

Total number of lines: 12

Run Date: 03-28-2004

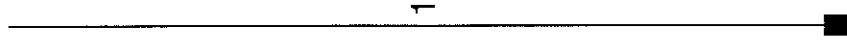
NOTES: Inlet N-Values = 0.016; Intensity = 71.37 / (Inlet time + 12.00) ^ 0.77; Return period = 25 Yrs.; \* Indicates Known Q added

# Hydraulics Grade Line Computations

Page 1

Line	Size	Q	Downstream						Upstream						Check	JL coeff	Minor loss						
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Len	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Energy loss (ft)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	15.06	902.50	904.13	1.63	2.74	5.49	0.47	904.60	0.448	87.0	903.10	904.47	1.37**	2.30	6.54	0.67	905.14	0.664	0.556	N/A	1.00	0.67
2	24	10.48	903.10	905.14	2.00	3.14	3.34	0.17	905.31	0.215	169	904.20	905.45	1.25	2.06	5.08	0.40	905.85	0.421	0.318	0.537	1.30	0.52
3	24	9.31	904.20	905.97	1.77	2.94	3.17	0.16	905.13	0.152	120	905.00	906.09	1.09	1.74	5.35	0.44	906.53	0.515	0.334	0.400	0.70	0.31
4	24	8.48	905.00	906.40	1.40	2.34	3.62	0.20	906.60	0.202	27.0	905.20	906.36	1.16	1.89	4.49	0.31	906.67	0.345	0.274	0.074	1.50	0.47
5	24	5.60	905.20	906.83	1.63	2.74	2.04	0.06	906.89	0.062	59.0	905.50	906.84	1.34	2.25	2.49	0.10	906.94	0.097	0.080	0.047	0.70	0.07
6	15	3.68	906.35	907.13	0.78*	0.81	4.55	0.32	907.45	0.634	128	907.20	907.97	0.77	0.79	4.63	0.33	908.30	0.662	0.648	0.830	2.50	0.83
7	18	4.06	903.85	905.14	1.29	1.62	2.51	0.10	905.24	0.139	238	905.60	906.37	0.77**	0.91	4.45	0.31	906.68	0.549	0.344	N/A	1.50	0.46
8	18	3.39	905.60	906.83	1.23	1.55	2.18	0.07	906.91	0.104	22.0	905.75	906.84	1.09	1.37	2.47	0.09	906.93	0.136	0.120	0.026	2.50	0.24
9	15	2.76	905.75	907.07	1.25	1.23	2.25	0.08	907.15	0.183	50.0	906.00	907.15	1.15	1.18	2.33	0.08	907.24	0.158	0.171	0.085	0.00	0.00
10	18	0.82	904.70	905.97	1.27	1.60	0.51	0.00	905.97	0.006	114	905.40	905.99	0.59	0.64	1.28	0.03	906.01	0.058	0.032	0.037	0.00	0.00
11	15	0.64	905.65	905.99	0.34	0.27	2.39	0.09	906.08	0.387	10.0	905.75	906.07	0.32**	0.25	2.58	0.10	906.17	0.476	0.432	N/A	0.00	0.00
12	15	1.54	903.95	905.14	1.19	1.21	1.28	0.03	905.17	0.049	82.0	904.60	905.19	0.59	0.57	2.72	0.12	905.30	0.283	0.166	0.136	2.50	0.29

## Hydraflow Plan View



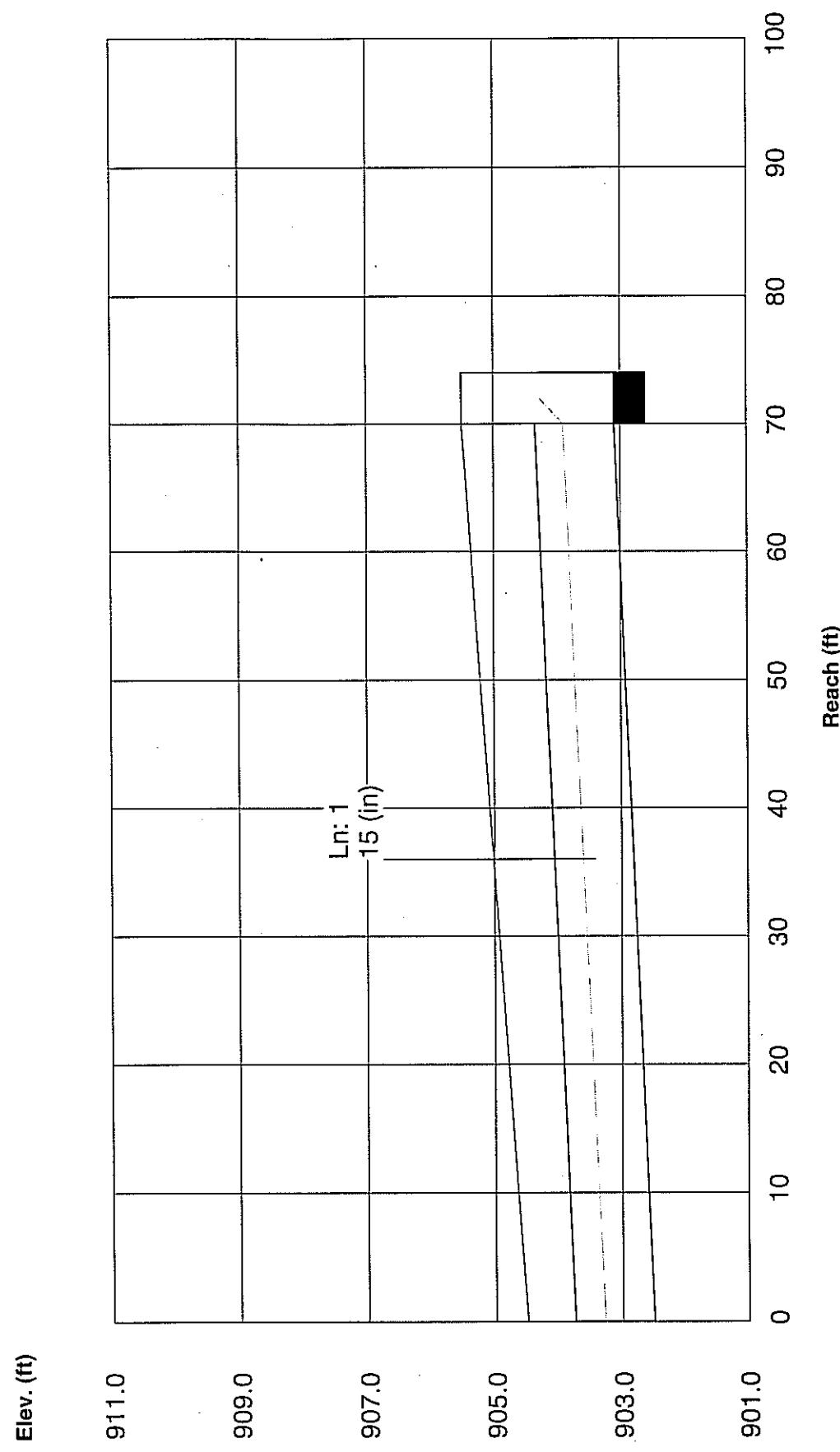
1

Project file: Storm Drain DI #12.stm

IDF file: Greensboro NC Hydro 35 for Storm Pipes.IDF. Lines: 1

03-26-2004

# Storm Sewer Profile



# Hydraulics Storm Sewer Inventory Report

Page 1

Line No.	Alignment				Flow Data			Physical Data				Line ID Inlet/Rim El (ft)					
	Drstr Line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drg area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Invert El Up (ft)	Line size (in)	Line type	N value (n)	J-loss coeff (K)			
1	End	72.0	90.0	DrGrd	0.00	0.66	0.73	4.0	902.50	0.83	903.10	15	Clr	0.013	1.00	905.50	Pond to Dr12
														Total number of lines: 1	Date: 03-26-2004		
IDF File: Storm Drain D1 #12.stm													Project File: Greensboro NC Hydro 35 for Storm Pipes.idf				

# Hydraflow Summary Report

Page 1

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	Dns line No.
1	Pond to DI12	4.11	15 c	72.0	902.50	903.10	0.833	903.28	903.91	0.37	End

Project File: Storm Drain DI #12.strm

IDF File: Greensboro NC Hydro

35

Total

No.

Lines:

1

Run Date: 03-26-2004

NOTES: c = circular; e = elliptical; b = box; Return period = 25 Yrs.; \* Indicates surcharge condition.

**Hazardflow Inlet Report**

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q bypass (cfs)	Junc type	Curb Inlet		Grate Inlet		Gutter						Inlet	Byp line No				
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	Sa (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	depth (ft)	spread (ft)				
1	Cover	4.11	0.00	4.11	0.00	DrGrt	0.0	0.00	1.01	2.00	2.00	Sag	2.00	0.125	0.125	0.024	0.57	11.18	0.57	11.18	0.0	Off

# Hydraulic Grade Line Computations

Page 1

Line	Size	Q	Downstream						Len	Upstream						Check	JL coeff	Minor loss					
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)		EGL elev (ft)	Sf (%)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Energy loss (ft)	(K)	(ft)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	15	4.11	902.50	903.28	0.78	0.81	5.09	0.40	903.68	0.791	72.0	903.10	903.91	0.81**	0.84	4.88	0.37	904.28	0.711	0.751	N/A	1.00	0.37
																						Total number of lines: 1	Run Date: 03-26-2004
											IDF File: Greensboro NC Hydro 35 for Storm Pipes.idf											Project File: Storm Drain D1 #12.stm	Run Date: 03-26-2004
NOTES: Initial tailwater elevation = 903.2822 (ft), * Normal depth assumed., ** Critical depth assumed.																						Project File: Storm Drain D1 #12.stm	Run Date: 03-26-2004

# Hydraflow HGL Computation Procedure

**General Procedure:** Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is assumed at the upstream end.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the assumed hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18).

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average  $Sf/100 \times \text{Line Length}$  (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

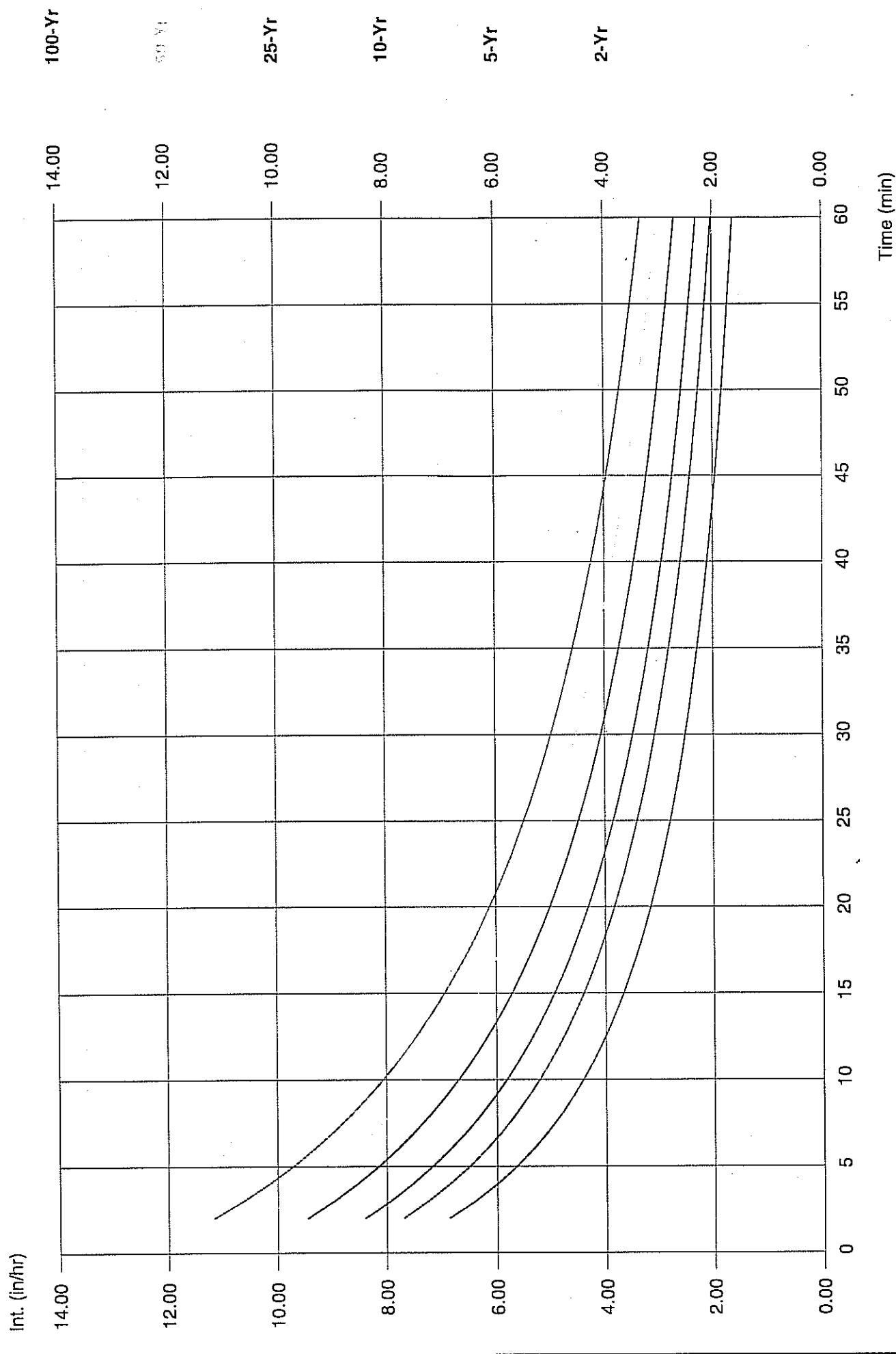
Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. Equals Col. 23 x Col. 18. This amount is added to the upstream HGL and used as the starting HGL for the next upstream line(s).

\* Normal depth assumed.  
\*\* Critical depth assumed.

# Hydrograph IDP Curves

1D file: Greensboro NC Hydro 35 for Storm Pipes.idf



# Hydraflow IDF Report

Page 1 of 1

Return Period (Yrs)	Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	40.0056	8.2000	0.7594	-----
3	0.0000	0.0000	0.0000	-----
5	50.7977	10.0000	0.7596	-----
10	58.7808	10.9000	0.7611	-----
25	71.3731	12.0000	0.7661	-----
50	80.9677	12.6000	0.7684	-----
100	91.2196	13.2000	0.7718	-----

W:\106770\_Greensboro City\0106770\_02707\_JCR - Transfer Station\WORKSHTS\Pond\Greensboro NC Hydro 35 for Storm Pipes.idf

$$\text{Intensity} = B / (T_c + D)^E$$

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.64	4.42	3.67	3.17	2.80	2.52	2.29	2.11	1.96	1.83	1.72	1.62
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.49	5.22	4.40	3.84	3.41	3.08	2.82	2.60	2.42	2.27	2.13	2.01
10	7.16	5.81	4.94	4.32	3.85	3.49	3.19	2.95	2.75	2.58	2.43	2.29
25	8.15	6.69	5.71	5.02	4.49	4.07	3.74	3.46	3.22	3.02	2.85	2.70
50	8.94	7.38	6.33	5.57	4.99	4.53	4.16	3.85	3.59	3.37	3.18	3.01
100	9.72	8.06	6.93	6.11	5.48	4.99	4.58	4.25	3.96	3.72	3.51	3.32

T<sub>c</sub> = time in minutes